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OCTOBER 1948

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO 10, ILLINOIS. ANNUAL SUBSCRIPTION, $10.00

Entered as Second Class Matter Jan. 14, 1925, at the Postoffice at Chicago, Under the Act of Congress of March 3, 1879

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LARYNGECTOMY: A SURGICAL TECHNIC WHICH PROMOTES RAPID HEALING

JOHN B. ERICH, M.D.
ROCHESTER, MINN.

IN ANALYZING 568 cases of carcinoma of the larynx encountered at the Mayo Clinic during the period from 1934 through 1943, my associates and I found that 48 per cent of the patients were treated by laryngectomy, 41 per cent by thyrotomy and 11 per cent by diathermy or application of radon during suspension laryngoscopy. In spite of the medical profession's intensive educational program to teach the public the value of early diagnosis in the treatment of cancer, it is apparent that in the greater number of malignant tumors of the larynx which we encounter the lesion is so extensive as to require total removal of the larynx rather than a more conservative procedure. Laryngectomy, therefore, still is an important therapeutic measure in the treatment of carcinoma of the larynx.

In recent years, much intensive work by capable laryngologists has changed the manner of performing laryngectomy from a faulty, and often unreliable, procedure, attended with a high mortality rate, to an accomplished surgical technic. Progressive refinements in this operation have practically eliminated any operative risk. From 1939 through 1944, 217 patients [1] underwent laryngectomy at the clinic for cancer of the larynx, with only 1 death, and this was the result of coronary thrombosis. Moreover, since 1945, only 1 operative death has occurred at the clinic among all our patients undergoing laryngectomy and, again, this fatality was due to coronary occlusion.

Advances in the treatment of cancer of the larynx not only have reduced the operative risk but have also greatly lessened the severity of postoperative symptoms and the duration of the convalescent period. It was our former experience at the clinic that the wound following laryngectomy required two or three weeks to heal. Last year I

From the Section on Laryngology, Oral and Plastic Surgery, the Mayo Clinic.

Read before the Section on Laryngology, Otology and Rhinology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 24, 1948.

1. New, G. B.; Figi, F. A.; Havens, F. Z., and Erich, J. B.: Carcinoma of the Larynx: Methods and Results of Treatment, Surg., Gynec. & Obst. **85**:623-629 (Nov.) 1947.

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discovered that with a change in the method of detaching the larynx from the pharyngeal mucosa and in the manner of closing the resultant pharyngeal opening three advantages ensue: 1. The Rehfuss feeding tube can be removed on the third to the fifth postoperative day, at which time the patient is able to swallow both food and liquids. 2. Prompt healing of the wound results, so that all sutures can be removed on the sixth day. 3. Most patients are able to be dismissed from the hospital on the sixth or seventh day. It is well to stress, however, that this operative procedure, which I shall describe, is applicable only to intrinsic laryngeal carcinomas which do not extend up onto the epiglottis.

The selection of patients with carcinoma of the larynx for laryngectomy is based on the location, extent and activity of the lesion. All carcinomas presented at the clinic are examined microscopically and are graded from 1 to 4 (Broders' classification), grade 1 being the least malignant and grade 4 the most malignant. We believe that all grade 1 and grade 2 and most grade 3 laryngeal carcinomas which have not metastasized can be treated more successfully by operation than by irradiation; our statistics show that about 93 per cent of all malignant tumors of the larynx are grade 1, 2 or 3. With regard to grade 4 lesions, it is our belief that irradiation is the treatment of choice unless the growth is very small and well localized.

At the clinic, all intrinsic laryngeal carcinomas which have infiltrated deep enough to produce fixation of one or both vocal cords but which have not metastasized to the cervical lymph nodes are treated by laryngectomy, unless the patient is extremely old or in poor general condition. If the lesion is very active, laryngectomy rather than thyrotomy (laryngofissure) usually should be undertaken whether or not there is fixation of the cord, because the extent of a high grade growth always is uncertain. With low grade malignant laryngeal tumors which show no clinical signs of metastasis but which have perforated the thyroid cartilage or the thyrocricoid membrane, the possibility of a permanent cure is often greater after laryngectomy than after irradiation.

Whenever any question exists as to whether or not a malignant tumor of the larynx can be successfully removed by thyrotomy, it usually is advisable to undertake laryngectomy rather than the more conservative operation. If the tumor recurs after thyrotomy, the possibility of curing the patient by laryngectomy is less likely than if laryngectomy had been employed at the start.

Laryngectomy may be accomplished in either one or two stages. With the one stage technic the entire larynx is removed in a single operation. The two stage procedure involves the insertion of a tracheotomy tube two or three weeks in advance of the laryngectomy. If the patient is in good health and has a fairly adequate airway, there

is no necessity of doing a two stage laryngectomy. The removal of the larynx in one stage has two advantages: First, it saves the patient considerable time and expense in hospitalization, and, second, it is easier, in many respects, to remove the larynx in a person who has not had a preliminary tracheotomy. However, if a patient with a laryngeal carcinoma has a greatly obstructed airway or if his general health is poor, or if he is very old, tracheotomy should be performed in advance of laryngectomy. In these circumstances, removal of the larynx should be postponed two or three weeks after the tracheotomy. This amount of time is necessary to permit all the inflammatory reaction attending the tracheotomy to disappear before removal of the larynx is attempted.

We never perform a laryngectomy at the clinic with the patient under general anesthesia; instead, we employ local cervical nerve block anesthesia. It is distinctly advantageous for the patient to be conscious during the operation because then blood which trickles down the trachea is coughed up readily. Moreover, general anesthesia is difficult to control when the anesthetic agent is administered through a tracheal cannula.

In a one stage laryngectomy the anesthetic for induction of a cervical nerve block may produce complete obstruction of the respiratory tract in cases in which the tumor is already impairing the laryngeal airway. The obstruction produced by the anesthetic may be so severe as to demand an emergency tracheotomy. In order to obviate this difficulty, I perform a tracheotomy just prior to the local administration of the anesthetic agent. By following this technic, no respiratory difficulty will be experienced by the patient during the injection of the local anesthetic or subsequently, during the surgical removal of the larynx.

TECHNIC

The technic which I follow in a one stage laryngectomy may be divided into three phases: (1) opening of the trachea, (2) administration of an anesthetic for cervical nerve block and (3) removal of the larynx.

First Phase of the Operation.—After proper sedation of the patient (pentobarbital sodium U. S. P., 1½ grains [0.097 Gm.] on the morning of the operation, and morphine sulfate, ⅙ grain [10 mg.], together with atropine sulfate, $\frac{1}{150}$ grain [0.4 mg.], on call) and the insertion of a Rehfuss feeding tube through a nasal cavity to the stomach, the trachea is opened through a midline incision extending from the upper border of the thyroid cartilage to the third or fourth tracheal ring. The ribbon muscles of the neck are separated along the median line and retracted, thus exposing the isthmus of the thyroid gland, which is divided in the

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midline. Bleeding vessels in this glandular structure are clamped and ligated. The cricoid cartilage and the upper three tracheal rings are now exposed. Before incision of the trachea, a few drops of a 10 per cent solution of cocaine hydrochloride U. S. P. are instilled in the trachea by means of a hypodermic syringe; this agent numbs the mucosa of the trachea and inhibits the coughing reflex when the trachea actually is opened. A disk of cartilage about 1 cm. in diameter is removed from the first and second tracheal rings and a no. 7 tracheal cannula is inserted.

Second Phase of the Operation.—Immediately after the insertion of the tracheotomy tube, the physician anesthetist performs superficial and deep cervical nerve blocks, employing for anesthesia a 0.5 per cent solution of metycaine hydrochloride® (racemic-3-benzoxy-1-[2-methyl-piperidino]-propane hydrochloride) for the former and a 1 per cent solution of the same drug for the latter. In addition to the cervical nerve block, the superior laryngeal nerve on either side is blocked with metycaine hydrochloride.®

Third Phase of the Operation.—The midline incision of the skin is carried upward to expose the anterior surface of the hyoid bone, which subsequently is divided in the median line with a large bone forceps. The cut edges of this bone are pulled forcibly apart with rake retractors. Division and retraction of the hyoid bone in this fashion greatly add to the exposure of the larynx and facilitate its removal. A median line incision of the skin, as described, and division of the hyoid bone give very satisfactory exposure for the subsequent operative procedure and is preferable to a T-shaped incision.

With the surgeon working first on the right side of the larynx with blunt dissecting scissors, the ribbon muscles are separated from the lateral aspect of the thyroid cartilage and thyroid gland. Attachments of the thyrohyoid and sternothyroid muscles along the oblique line of the thyroid cartilage are carefully detached. The cricothyroid branch of the superior thyroid artery is divided and ligated. The right side of the larynx now is completely freed by this technic, which then is repeated in similar fashion on the left. By means of ribbon retractors, the soft tissues are held away from the larynx as it is severed from the trachea. In most patients the anterior branch of the superior thyroid artery will be seen coursing down over the lobe of the thyroid gland on either side. It is decidedly advantageous to expose and ligate these vessels, for the amount of bleeding that occurs when the trachea is cut across is greatly reduced.

Unless the malignant tumor extends far subglottically, the trachea is cut across immediately below the cricoid cartilage. When making this cut I retract and stabilize the larynx by engaging the cricoid

cartilage with a large hook or forceps. The incision is carried down to the posterior wall of the trachea. In most instances a tongue-shaped flap of laryngeal mucous membrane over the posterior surface of the cricoid cartilage is elevated and left attached to the trachea (fig. 1); this facilitates the final closure of the wound. The larynx, when detached from the trachea, is elevated; adjacent thyroid tissue and the underlying pharyngeal and esophageal mucosa are stripped away by digital pressure. Next, the greater horns of the thyroid cartilage are disengaged from the surrounding soft tissues. Unless each cornu is detached with extreme care, tears in the pharyngeal mucosa may occur; this compli-

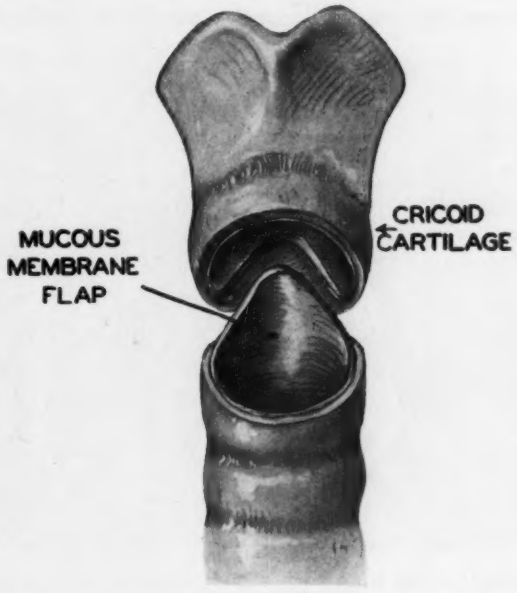

Fig. 1.—When the larynx is severed from the trachea, a flap of laryngeal mucous membrane over the posterior surface of the cricoid cartilage is left attached to the trachea; this facilitates the final closure of the wound.

cation can completely ruin the opportunity to suture the pharyngeal opening so that it will be impermeable to saliva and other fluids. At this stage the superior laryngeal artery on either side should be clamped, divided and ligated. The foregoing steps in the operative procedure completely free the larynx except for its mucosal attachment to the pharynx.

Whenever possible, I prefer to leave the epiglottis intact (fig. 2*a*). Many surgeons believe that the epiglottis should always be removed together with the tissues forming the thyrohyoid membrane. However, I am of the opinion that this is unnecessary when the growth is confined

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to the vocal cords or the subglottic region. Of course, when an epithelioma extends supraglottically, removal of the epiglottis becomes essential.

If the epiglottis is to be retained, the larynx is elevated in the wound and the pharyngeal mucous membrane is cut across close to the upper border of the thyroid cartilage, as illustrated in figure 2 *b*. This leaves a comparatively small pharyngeal opening, which is closed in a vertical direction with plain 00 surgical gut; this suture is continuous, similar to Lembert's method of suturing an intestinal wound in which the needle picks up only the submucosal tissues, thereby permitting the margins of the mucous membrane to be inverted into the pharynx (fig. 2 *c*). Stretching the pharyngeal wound in a vertical direction by

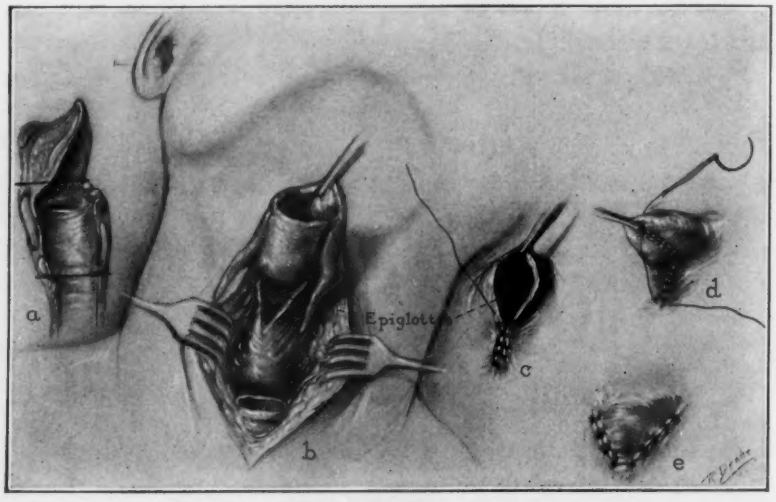

Fig. 2.—Removal of the larynx, leaving the epiglottis and the thyrohyoid membrane intact. (*a*) The two solid lines indicate the upper and lower horizontal incisions for removal of the larynx. Note that the greater part of the epiglottis and thyrohyoid membrane are left intact. (*b*) The pharyngeal mucous membrane is cut across close to the upper border of the thyroid cartilage. (*c*) The larynx is removed. The intact epiglottis is visible. The resultant pharyngeal opening is being closed in a vertical direction with a continuous plain surgical gut suture. (*d* and *e*). The stump of the epiglottis and adjacent tissues of the thyrohyoid membrane are folded downward and sutured in V-shaped fashion; this technic completely buries the vertical pharyngeal suture line and makes the wound watertight.

retraction on hooks placed at either end of the mucosal opening is helpful during the process of suturing, which is executed from below upward. After closure of the pharyngeal opening, as described, the stump of the epiglottis and the adjacent tissues of the thyrohyoid membrane are folded down and sutured in V-shaped fashion (fig. 2 *d* and *e*). With this technic the vertical pharyngeal suture line is completely buried and a watertight closure of the wound is provided.

When the epiglottis is to be removed along with the larynx, the technic illustrated in figure 3 is employed. An incision across the pharyngeal mucosa in the arytenoid region exposes the interior of the pharynx. The tip of the epiglottis can then be retracted into the wound by means of a long hook or forceps (fig. 3 *b*). With the use of sharp-pointed scissors, the ventral surface of the epiglottis is freed from the underlying tissues (fig. 3 *b*), thereby saving the greater portion of the thyrohyoid membrane to aid in the final closure of the pharyngeal opening. The remaining mucosal attachment of the larynx to the pharynx is severed, and the larynx is removed.

When the epiglottis is removed as just described, a much larger pharyngeal opening is effected than when the epiglottis is left intact. However, when the thyrohyoid membrane is saved, even though the

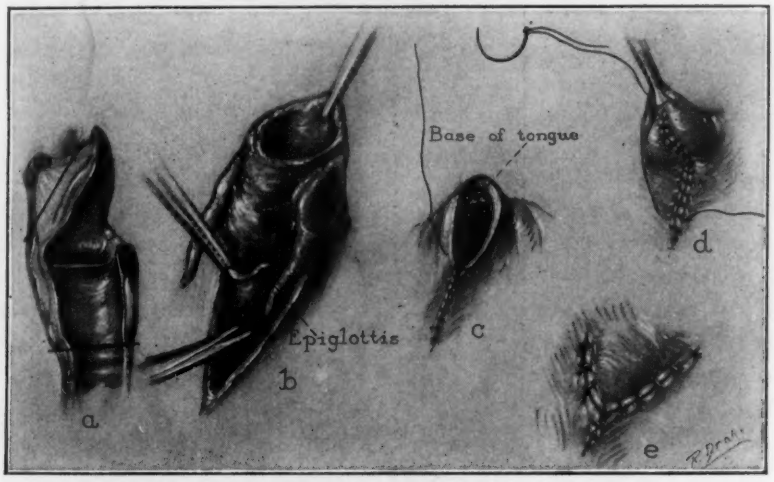

Fig. 3.—Removal of the larynx and epiglottis, but with the greater portion of the thyrohyoid membrane left intact. (*a*) The two solid lines indicate the horizontal incisions for removal of the larynx. Note that the epiglottis is removed but that the greater part of the thyrohyoid membrane is left intact. (*b*) The pharyngeal mucosa is opened to expose the interior of the pharynx. The epiglottis is retracted up into the wound, and scissors are used to free the ventral surface of the epiglottis from the tissues of the thyrohyoid membrane. With this technic the greater part of the thyrohyoid membrane is saved, facilitating closure of the wound. (*c*) The larynx has been removed. The resultant pharyngeal opening is being closed in a vertical direction with a continuous plain surgical gut suture. (*d* and *e*). The remaining tissues of the thyrohyoid membrane are folded downward and sutured in V-shaped fashion; this buries the vertical pharyngeal suture line and makes the wound watertight.

epiglottis is sacrificed, the pharyngeal opening can still be sutured in a manner similar to that illustrated in figure 2. After removal of the larynx and epiglottis, I place six or eight Allis forceps around the pharyngeal opening so that the edges can be retracted and the opening clearly visualized. With plain 00 surgical gut on a curved needle, this

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opening is closed with a continuous suture placed in a vertical direction, beginning at the lower border of the wound (fig. 3 *c*). Even though the epiglottis has been removed, the greater part of the thyrohyoid membrane still is present and can be folded down and sutured in V-shaped fashion (fig. 3 *d* and *e*). The thyrohyoid membrane thus buries the greater part of the vertical suture line and makes the wound watertight. I have found that these wounds heal as promptly as those with the epiglottis left intact.

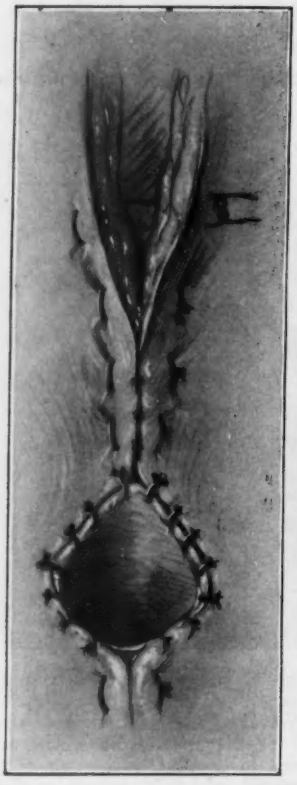

Fig. 4.—Cutaneous edges of the wound are sutured to the cut edges of the trachea and the flap of laryngeal mucous membrane. Mattress sutures approximate the margins of the wound above the tracheal opening.

After closure of the pharyngeal opening, a chromic surgical gut suture is employed to approximate the divided edges of the hyoid bone. The cutaneous margins of the wound are sutured to the upper (cut) end of the trachea with heavy silk or cotton thread (fig. 4). No attempt is made to suture the skin to the tracheal mucosa only. Instead, these sutures often pass through the uppermost cartilaginous ring of the trachea. Suturing the edges of the skin to the trachea in this fashion gives a much stronger union than merely approximating the skin and

mucous membrane. Just above the tracheal opening three or four heavy white silk or cotton mattress sutures are inserted to bring together the lateral margins of the wound and obliterate the large cavity (fig. 4). Before the mattress sutures are tied, however, penicillin powder is instilled in the wound. Black C silk sutures approximate the skin edges themselves. Drainage of the wound is provided by a single Penrose drain inserted up under the hyoid bone and emerging in the median line.

After operation, the patient is given 30,000 units of penicillin by intramuscular injection every three hours for three or four days. The convalescent period can be shortened by having the patient get out of bed the day after operation, whether or not he has a fever. With the aid of a nurse, he rises from bed, takes a few steps around the room and returns to bed. This procedure is repeated two or three times the first day and for longer periods on subsequent days. By the fourth day, the patient usually can sit up in a chair and can walk about the room.

By following the technic described, I have found that laryngectomy wounds remain dry, with no seepage of saliva. By the third to the fifth postoperative day the patient is able to swallow food and liquids, permitting removal of the Rehfuss feeding tube. Some patients, because of discomfort or trouble with deglutition, at first are reluctant to take food by mouth, but with encouragement, they soon can swallow their meals without difficulty. On the fifth day the Penrose drain is withdrawn, and by the sixth day all sutures are removed. Unless they are old or debilitated, most persons who have followed the regimen described are able to leave the hospital on the sixth or seventh day after laryngectomy.

SUMMARY

A technic for laryngectomy which maintains a dry wound after operation is described. This technic permits removal of the Rehfuss feeding tube on the third to the fifth postoperative day and dismissal of most patients from the hospital in six or seven days.

The Mayo Clinic.

ABSTRACT OF DISCUSSION

DR. LE ROY A. SCHALL, Boston: I should like to emphasize that Dr. Erich's operation is for carcinoma of the larynx limited to the vocal cord. I wish there were a standard concept of what is meant by intrinsic carcinoma. Anatomically, the larynx includes the epiglottis and the aryepiglottic fold, and I consider any growth within the funnel as intrinsic. I am never certain in the case of carcinoma of the larynx whether the growth is limited to the vocal cord or to the ventricle.

After seeing the beautiful work of Bisi on the preepiglottic space, in finding carcinoma in the pretracheal muscles in cases in which, macroscopically, the

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cancer seemed localized to the vocal cord, in finding the carcinoma in the thyroid gland, which on inspection did not seem to be involved, and in finding involvement of lymph nodes along the carotid sheath which I could not detect before operation, I have become more radical in operating on carcinoma of the larynx. I no longer leave the epiglottis, nor have I ever left the pretracheal muscles. I even remove the anterior belly of the omohyoid muscle. I always remove the body of the hyoid bone, and frequently the entire bone. With the aid of chemotherapy and antibiotics, my patients, too, have been leaving the hospital, not in six days, but in eleven days or two weeks.

My associates and I are concerned not so much with getting our patients out of the hospital quickly as with their rehabilitation. We start them all on preoperative voice training; as soon as the feeding tube is removed, on about the fourth or fifth day, the patient has two lessons a day in use of the esophageal voice, and most of them are talking at the end of two weeks.

I wish to congratulate Dr. Erich. His surgical technic is excellent, but I should like to emphasize again that this operation is for carcinoma which is not extensive.

DR. LOUIS H. CLERF, Philadelphia: When one modifies an operative procedure for treatment of carcinoma, one must not fail to remember the objectives for which the operation is being done. In a paper which I presented recently, I concluded by stating that I was becoming more radical in my surgical procedures rather than less so, and I shall continue in this policy.

In many respects, Dr. Erich's procedure parallels mine. I also prefer local anesthesia and a midline incision. One can remove practically any growth in the neck through a midline incision. Instead of dividing the hyoid bone in the midline, I routinely take out either the body of or the entire hyoid bone, depending on whether or not the carcinoma is extensive. Carcinomas to which this procedure is applicable include those of the vocal cord, for which a laryngectomy is performed.

I separate the larynx from above downward, because I thus have an opportunity to visualize what I thought I saw by mirror and direct laryngoscopy. I have been surprised on occasions to find that the lesion is larger than I had expected; other surgeons have had a similar experience.

I remove the epiglottis routinely. Dr. Erich has indicated that he uses the epiglottis to reenforce the closure. That may be a function of the epiglottis; other than that, I know of no reason for leaving it. In the average case I should be afraid to leave it. I agree with Dr. Schall on the removal of ribbon muscles; removal of everything possible is probably for the patient's best interest.

I have never been in a hurry to remove a feeding tube; probably I could remove it earlier than I do. I do not know that the presence of the feeding tube for a week, or even ten days, interferes seriously with the healing; this has not occurred in my experience.

I also have patients remain in the hospital for ten days or more. The wounds now heal by first intention, with rare exceptions. We surgeons must continue to improve our technic, but it is important not to sacrifice objectives in attempting to get our patients out of the hospital early or have them swallowing early. I propose to err on the conservative side.

DR. C. L. JACKSON, Philadelphia: Dr. Erich's beautiful film emphasizes that one must constantly keep reviewing criteria for selection of treatment, whether by surgical measures or by irradiation and the particular technic of each.

Indications for the more conservative operations must be strictly adhered to if they are to be preserved and kept as established methods for the particular

cases to which they are suited; this applies to laryngofissure and to these special technics of laryngectomy.

With regard to the treatment of the epiglottis, we all are inclined to agree that if a lesion involves the vocal cords or the subglottic region it is permissible to leave a portion of the epiglottis. It is now left in few cases. If the epiglottis is removed with the rest of the larynx, as is generally done, the midportion of the hyoid bone is removed routinely, rather than being divided, as Dr. Erich does, because it is easily skeletonized and removed; then one does not have to retract its two cut halves. Removal of the whole hyoid bone is easy enough, but unnecessary.

Dr. Joseph P. Atkins, Philadelphia: At the University of Pennsylvania we have been using a technic of laryngectomy devised by Dr. Gabriel Tucker, which has been very successful. Many aspects of it resemble this excellent presentation of Dr. Erich's, and I have some of Dr. Tucker's slides here which demonstrate this. One difference between his procedure and ours is that we attach the tracheal stump to the skin by means of an inverted T incision.

Dr. John B. Erich, Rochester, Minn.: I wish to emphasize again that the technic shown in this moving picture is applicable only to carcinomas involving the vocal cords or the subglottic region. My associates and I have never felt that with the type of carcinomas I am speaking of removal of the epiglottis, the hyothyroid membrane or the hyoid bone is necessary. Of course, this refers only to the low grade carcinomas, not to those that are highly active.

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CARCINOMA OF THE NASOPHARYNX

C. CALVIN FOX, M.D.
PHILADELPHIA

CARCINOMA of the nasopharynx has always had a high mortality rate because in an unfortunately high percentage of cases the disease is not recognized until it has reached an advanced stage. As with all other types of cancerous new growth, the greatest factors for successful results are that a diagnosis be made early and that the tumor be accessible to the most vigorous appropriate treatment.

The statistics of this article are based on a series of 12 cases that have been studied and followed in private practice, in the department of laryngology of Jefferson Medical College and in the tumor clinic at Jefferson Medical College Hospital.

The cause of carcinoma of the nasopharynx is as uncertain as that of cancer elsewhere. The nasopharynx is subjected to a great amount of irritation that may have a sinister effect in persons who have hyperplastic tendencies. All patients examined complained of a marked chronic postnasal discharge. The histories failed to show a hereditary tendency.

There still is considerable disagreement as to the pathologic nature of these tumors. Most of the recent reports describe the transitional cell lymphoepithelioma, but in this series the histopathologic diagnosis was anaplastic squamous cell carcinoma in 6, or 50 per cent, of the cases, transitional cell carcinoma in 4, or 33.3 per cent, and anaplastic cell carcinoma in 2, or 16.7 per cent. In all the cases the carcinoma was atypical, showing variations of the arrangement of the cells, a high percentage of which were young, undifferentiated and therefore highly radiosensitive. Most authorities agree with Ewing that cancers of the nasopharynx can be grouped under the term of transitional epithelial cell carcinoma. In many recent articles authors record their cases as instances of lymphoepithelioma, as described by Schmencke. The presence of lymphoid tissue in this region insures the presence of lymphoid cells in the biopsy specimens. Many of the slides contain areas that could easily be mistaken for lymphosarcoma.

From the Department of Laryngology, Jefferson Medical College.

Read before the Section on Otolaryngology of the College of Physicians of Philadelphia, Dec. 17, 1947.

It is imperative that a thorough history be taken, with special emphasis placed on symptoms and signs that seem trivial at the onset but are persistent or gradually become intensified.

The ages of the patients reviewed ranged from 32 to 74 years. Eight patients out of the 12 were in a group between 40 and 60 years and were therefore at the typical cancer age. It should be stated that cancerous disease of the nasopharynx has been rather frequently reported at much earlier ages. Martin and Blady [1] treated a 4 year old child; Whiteleather,[2] a patient of 10 years, and Prohovnik,[3] one of 14 years of age, while others have attended patients of almost any age.

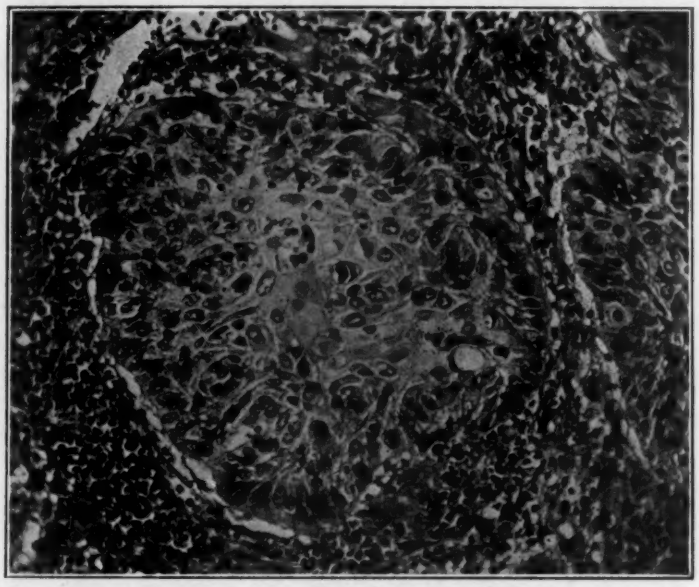

Fig. 1.—Photomicrograph of squamous cell carcinoma of the nasopharynx. There is little stroma. The cells show mitotic figures, and some are polyhedral. The neoplasm is infiltrating the tissue.

Authors frequently have reported that males are more often affilicted than females, but in this series 8 patients were females and 4 males. The more recent publications do not show as great preponderance of males as was formerly reported. It is possible that the increased numbers of women who indulge in smoking and participate in industry have been factors in equalizing the figures.

1. Martin, H. E., and Blady, J. V.: Cancer of the Nasopharynx, Arch. Otolaryng. **32**:693-727 (Oct.) 1940.

2. Whiteleather, J. E.: Transitional Epithelial Cell Carcinoma of the Nasopharynx, Am. J. Roentgenol. **54**:357-369 (Oct.) 1945.

3. Prohovnik, J.: Carcinoma of the Nasopharynx in a Boy Fourteen Years of Age, Eye, Ear, Nose & Throat Monthly **24**:187-189 (April) 1945.

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The most important symptoms to remember are the earliest ones. Four of them should always be regarded with the greatest suspicion, particularly when two or more are simultaneously present. They are: cervical adenitis, earache or (and) some degree of deafness, hemoptysis and nasal obstruction. They have been found in this order of frequency. New,[4] in a series of 194 cases, found cervical adenitis as the first symptom in 42 per cent. This is the same percentage in which it was found in the small group herein reported. Earache or deafness, or both, were present as a first symptom in 33.3 per cent, hemoptysis in 25 per cent and nasal obstruction in 25 per cent. Nasal obstruction probably is a later symptom than the other three because it would necessitate a

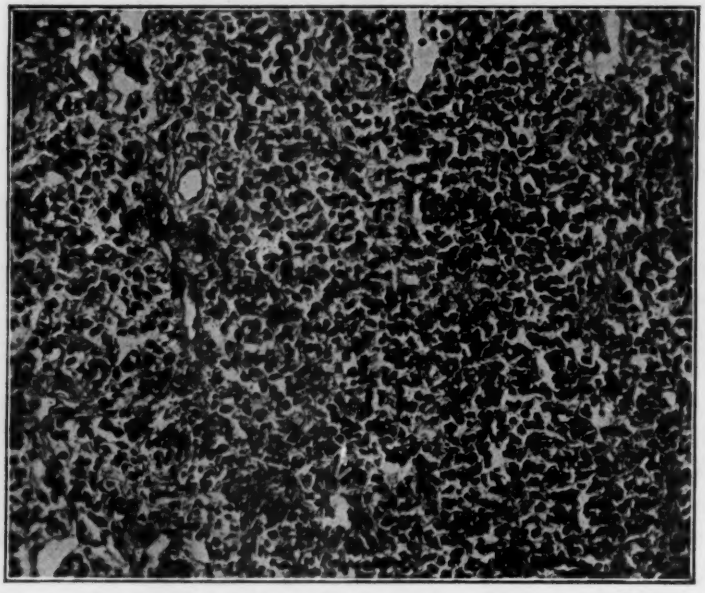

Fig. 2.—Photomicrograph of transitional cell carcinoma of the nasopharynx. Some fibrous and hyaline changes may be seen. There is impressive round cell infiltration. Many new vessels are present.

considerable mass of tumor tissue in the nasopharynx, unless it arose close to or in the choana. Less frequent first symptoms are pain in the nasopharynx or along the distribution of the trigeminal nerve, headaches, disturbances of swallowing and almost always an increase of postnasal secretion.

The cervical adenitis is first an involvement of one or more nodes just below the ear, posterior to the angle of the mandible. They are at first firm, discrete, slightly fixed to the underlying tissues but not

4. New, G. B.: Highly Malignant Tumors of the Nasopharynx and Pharynx, Tr. Am. Acad. Ophth. **36**:39-44, 1931.

to the skin. They tend to increase in number and size rather rapidly in both the anterior and the posterior triangle of the neck. They become coalesced into a large, firm mass fixed to the deeper structures. In a number of cases the lymph nodes on the opposite side of the neck become enlarged, owing often no doubt to the infection and inflammatory reaction present in the entire nasopharynx rather than to metastasis (fig. 4).

Symptoms indicating early involvement of the eustachian tube were second in frequency. Two patients first noticed partial loss of hearing in one ear; one first had earache, while a fourth had both earache and loss of hearing. The fourth eventually had suppurative otitis media,

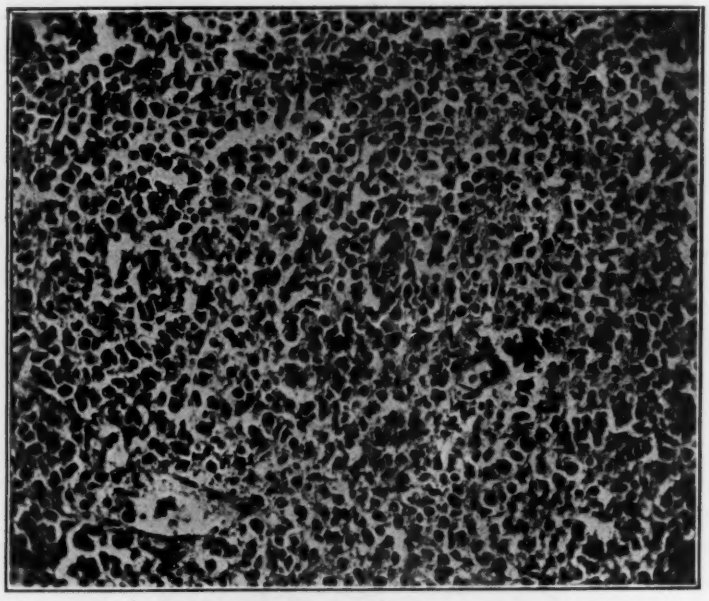

Fig. 3.—Photomicrograph of anaplastic carcinoma of the nasopharynx. The cells are large, with fair amounts of cytoplasm and round, oval and vesicular nuclei. Mitotic figures are numerous.

which was active until the nasopharynx improved. Some of the patients had tinnitus, but it was not an initial symptom. It can be assumed that failure to have earache early was due to the fact that in most of the cases the initial lesion was located on the anterolateral wall of the nasopharynx.

Hemoptysis was the first symptom in 3 cases. The amount of bleeding is at first so slight that there is a mere streaking of the sputum when the throat and the nasopharynx are cleared. Such small amounts of blood in the absence of cough are too often regarded as of little significance. When an appreciable amount is present it is not unusual

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to find blood streaks in the nasal secretion also or even definite epistaxis. If the growth is located on the lateral wall of the nasopharynx adjacent to or involving the choana, bleeding from the nose will occur earlier than when the carcinoma arises elsewhere. Any tendency toward even a slight amount of sanguineous postnasal discharge is sufficient cause for careful examination to determine its source. One such search with negative results should not be considered final because it is surprisingly difficult to detect the early cancerous changes.

Nasal obstruction does not occur as a first symptom unless the tumor is located in the anterolateral part of the nasopharyngeal wall

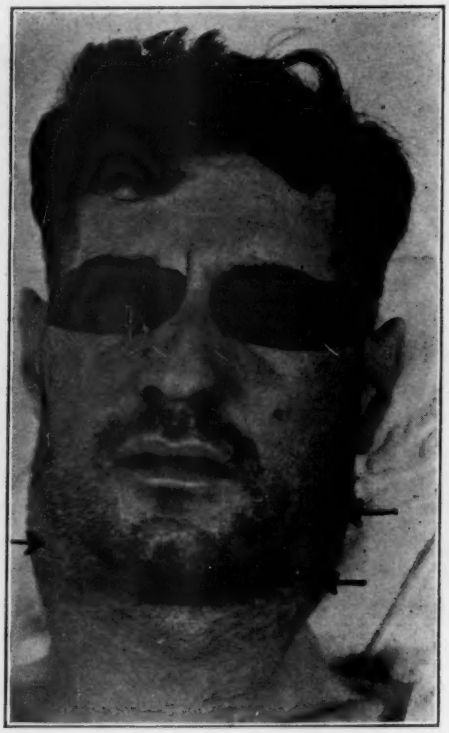

Fig. 4.—Squamous cell carcinoma of the nasopharynx with massive bilateral involvement of the cervical lymph nodes. The period of survival was twenty-seven months.

and has either infiltrated the lateral choanal wall or protrudes across the choanal orifice. In either instance the tumor has already assumed considerable size. In such cases the patient often complains of an excessive amount of secretion in one side of the nose and invariably has some bleeding when the nose is examined or treated. Whenever an applicator withdrawn from the posterior portion of the nose or the nasopharynx is bloody or blood is then found in the oropharynx, it is

advisable to determine whether the mucosa has been traumatized or whether neoplastic tissue is present. Any nasal obstruction caused by abnormal or soft tissue other than polyps requires that a biopsy be done. Too often operations have been done and repeated in an effort to clear the nasal airway, only to have a belated biopsy show that a malignant growth has been allowed to gain fatal headway.

Other early symptoms that appeared almost simultaneously with the four just related are pains in the frontal area and the face along the distribution of the trigeminal nerve, hoarseness and some disturbance in swallowing. The facial pain may be a dull ache, particularly in the face or the teeth, or it may be sharp, lancinating and neuralgic, radiating to the templar and preauricular regions. At the onset the pain is slight and comes at infrequent intervals, but gradually it increases in intensity, frequency and distribution until it may be excruciating.

Symptoms that follow those just discussed can be regarded as late ones. They are added while the intensity of the early symptoms is gradually increasing. They are caused as the tumor extends into the surrounding structures. Most of them are due to involvement of the cranial nerves as the neoplasm infiltrates the base of the skull and invades the middle fossa. In 6 cases, or 50 per cent of this series, paralysis of one or more cranial nerves developed. New [4] reported that 31 per cent of 194 patients had such symptoms. Martin [5] found 33.3 per cent of his patients with these disturbances. Speculation as to whether the carcinoma enters the cranial cavity by way of the sphenoidal fissure or by infiltration and erosion of the greater wing of the sphenoid bone would be difficult to determine. There probably is no uniform pathway of invasion. The basal foramens, particularly the sphenoidal fissure, provide an easy route, but in some cases there was roentgenographic confirmation of the belief that the bone had been widely eroded. Undoubtedly, either or both routes may be taken. The nerves most frequently involved were the third, fifth, sixth, ninth, tenth, eleventh and twelfth. Five patients, or 42 per cent, had disturbance of the fifth nerve, expressed in varied degrees of facial pain. One patient had anesthesia over the distribution of the second division of the nerve. Two patients had anesthesia of the cornea with loss of the corneal reflex because of invasion of the first division of the trigeminal nerve. In another case the corneal reflex was absent not because of tumor invasion but because in the course of rhizotomy to divide the second and third divisions of the fifth nerve subdurally in the semilunar ganglion some of the fibers to the first division were severed (fig. 5). The third nerve was involved in 2 patients who had dilatation of the pupil.

5. Martin, C. L.: Cancer of the Nasopharynx, Ann. Otol., Rhin. & Laryng. **52**:146-160 (March) 1943.

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The sixth nerve was involved in 1 patient, causing diplopia. In 2 patients symptoms of disturbance of the ninth, tenth, eleventh and twelfth nerves were found either alone or in combinations. These patients had severe cervical adenopathy, and it seems reasonable to suppose that the metastatic mass in the cervical lymph nodes could, by extracranial compression, have caused some of the symptoms referred to these nerves. It must be recognized, however, that in other cases, with no intracranial involvement, large masses did not produce lesions of these nerves. The 2 patients having these symptoms also showed roentgen evidence of severe erosion of the base of the skull. In 1 patient disturbance of the ninth nerve caused difficulty in swallowing and loss of the sense of taste. Involvement of the tenth nerve caused difficulty in swallowing and laryngeal paralysis in 2 patients. Hoarseness, observed in some instances, was also probably due to pressure on the tenth nerve. Interference with the eleventh nerve caused weakness of the shoulder muscles in 1 patient, and in 1 patient a disturbance of the twelfth nerve caused paralysis of the tongue.

Physical examination of the patients should include inspection of the immediate region of the lesion, examination of distant parts for evidence of metastasis, roentgen examination, biopsies of tissues and laboratory studies of blood, urine and other systems as indicated. Both posterior rhinoscopic and nasopharyngoscopic examinations are necessary, but proficiency in the use of a good scope is the greatest asset. Repeated examinations are necessary to make an accurate diagnosis and to observe the progress of the disease.

The eustachian orifice, the fossa of Rosenmüller, the posterior wall and the area extending from the lateral border of the choana to the posterior limit of the nasopharynx above and anterolateral to the tube are the areas where the initial lesion is most often found. The lymphoepithelioma seems to originate most often in the highly lymphogenous immediate vicinity of the eustachian tube, while the squamous cell varieties in this series showed a predilection for the area above the tube on the lateral wall, where significantly it is unusual to find any appreciable amount of lymphoid tissue. In 9 cases the cancer was first seen on the superolateral wall of the nasopharynx; in 2, in the fossa of Rosenmüller, and in 1, on the posterior wall.

Regardless of the cell type, the early cancer tissue is difficult to distinguished, by inspection, from hypertrophied lymphoid tissue. On close scrutiny, however, it has an elevated, more soft and spongy appearance, is finely granular at first but later becomes more coarse. It has irregular outlines and a slightly inflamed surface, with possibly some distended capillaries about its margins. It gives the impression that it could be easily scraped away, and bleeds easily when manipulated. Later there is ulceration with a foul odor. It is not unusual to see

a large amount of edematous or polypoid tissue in this area, but it does not have the same appearance as the tumor being discussed. As the tumor develops, it can become large enough to encroach on the choana, extend to the opposite side, pass into the eustachian tube or, by erosion, destroy any structure in the nasopharynx, including bone. The initial tumor ultimately develops an ulcerated appearance and hemorrhagic points. Exposure of bone was not found in these cases until after considerable radiation therapy had been given. This is explained by the fact that the tumor covered the bone until the roentgen

Fig. 5.—Transitional cell carcinoma of the nasopharynx (microscopic aspect shown in figure 2). This patient was still living ten years after the diagnosis was made. There have been occasional intervals of unexplained swelling in the right temporal and periorbital regions. Flattening and anesthesia of the right side of the face followed rhizotomy.

therapy melted away the soft neoplastic mass to expose the necrotic bone surrounded by a crusted crater-like depression. After heavy roentgen therapy has arrested the process, the exposed bone looks dark or charred and may be mistaken for a heavy crust.

A positive diagnosis of carcinoma cannot be made until a biopsy is done. This procedure should be carried out before roentgen therapy

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is started, because with these sensitive tumors, an application or two can so decrease the growth that a biopsy is difficult. It is desirable to take the tissue from deep in the tumor to insure the greatest accuracy in diagnosis. The histologic study gives information regarding the degree of invasiveness, the expected rate of metastasis and the radiosensitivity of the tumor.

Metastasis usually occurs fairly early. The most frequent extension involved the cervical lymph nodes. Various authors have reported it in 80 per cent or more of cases. In this series it was observed in 10 cases, or 83 per cent. Next in frequency was involvement of the ribs, in 3 cases. One patient showed marked destruction of the fifth rib. This same patient had metastases in a lung and the skull (fig. 6). One patient had an interesting metastasis in the thyroid gland, and another had involvement in the brachial plexus, as evidenced by weakness and great swelling of the arm. Whiteleather [2] reported metastases involving the long bones and the spine. Gollom [6] stated that below the clavicle general metastasis often occurs fairly rapidly in the chest, bones, the liver, the kidneys, the spleen and the retroperitoneal lymph nodes.

Roentgenographic studies are of diagnostic aid when the tumor has become large enough to project into the cavity of the nasopharynx. Lateral or mentovertex views are used for these studies, and they should be taken at various angles because of the variation in the bones and the location of the tumor. Alteration, erosion or obliteration of the foramens, especially the foramen lacerum medium, the foramen ovale, the orbital fissures and the jugular foramen, are most often found. Invasion and destruction of the sphenoid bone and the petrous part of the temporal bone can be shown when the neoplasm is advanced. In 2 cases of this series it was possible to see the tumor projecting into the nasopharyngeal space. Three patients had erosion of the sphenoid bone; 1 had erosion of the foramen lacerum medium, and 1 had rather extensive destruction of the petrous portion of the temporal bone. This patient also had the tumor tissue in the middle ear. It could not be determined whether it reached the ear by way of the eustachian tube or whether it extended from the involved petrosa. It can be seen that the roentgen studies gave evidence of the tumor in 50 per cent of cases, but not until the growth was well beyond the primary stage. Roentgen examination is of great value in locating metastases in the bones and body cavities.

A rather high percentage of patients had previously undergone various operative procedures. Three patients in this series had such

6. Gollom, J.: Lymphoepithelioma of the Nasopharynx, Canad. M. A. J. **52**:509-510 (May) 1945.

operations. In 2 patients the operations were to relieve nasal obstruction, and 1 patient underwent both a sinus operation and tonsillectomy.

Treatment of nasopharyngeal carcinoma has resolved into almost universal use of radiation therapy. This is due to the fact that the tumors are highly sensitive to both roentgen rays and radium and very inaccessible to other measures. In order to achieve the greatest benefit it is essential that there be close cooperation between the roentgenologist and the otolaryngologist, while the appropriate management of anemia and asthenia requires the skill of a competent internist. Penicillin therapy has been a great help in combating the troublesome secondary infections and acute diseases of the upper respiratory tract. In all the cases reported here the tumor was irradiated with roentgen

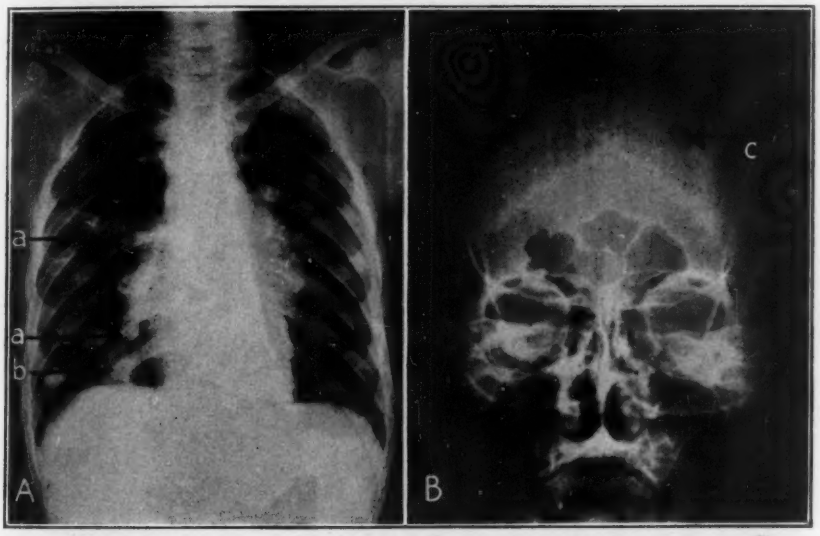

Fig. 6.—Squamous cell carcinoma of the nasopharynx (microscopic aspect shown in figure 1), with metastases in the ribs (*a*), the lungs (*b*) and the skull (*c*).

rays. Only 1 patient, treated in 1938, had radium used initially. It is agreed that the initial dose of roentgen radiation should be of maximum amount. A dose of 3,500 r (in air) directed through each part of the tumor is considered necessary. The patients treated in recent years at Jefferson Medical College Hospital by Dr. T. P. Eberhard have shown remarkably favorable results. Patients are started with a 10 by 15 cm. field extending from the level of the brow to the level of the cricoid cartilage, with additional coverage to fit the case when indicated. With the larger fields the treatment may be given to the opposite side on alternate days. When excessive

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mucous secretion or drying occurs either the size of the dose or the size of the field is reduced. At other times the field may be split into two parts and each treated with a smaller dose. The larger fields are treated with up to 250 r per day for a total of 2,500 to 3,000 r (in air). If two smaller fields are used, the daily dose is 125 to 150 r each. Next the treatment is applied to a port over each antral area until a total of 2,000 to 2,500 r (in air) has been reached by a daily dose of 225 to 250 r. After this a port through the frontal area above the brow is used and the radiation directed downward through the petrosa if the lesion is in the petrous apex or the orbit. Finally a port through the occiput is used to reach the same dose. Other roentgenologists may vary somewhat in their technic, and thorough discussions have been given by Whiteleather [2] and Martin.[5]

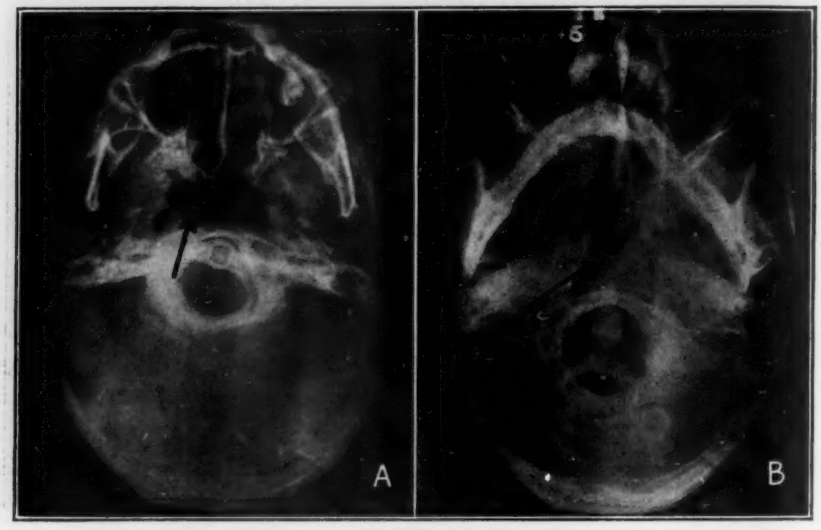

Fig. 7.—*A*, carcinoma of the nasopharynx invading the nasopharyngeal space on the right. *B*, carcinoma of the nasopharynx invading the nasopharyngeal space on the right. Note the erosion of the greater wing of the sphenoid bone and the sphenoidal fissure.

The survival period shows wide variation in the cases studied. Six patients are living and 6 are dead. Those who died had an interval between the primary symptom and death that varied from six to more than twenty-seven months, with only 1 patient living to more than twenty-seven months. Of the patients still living, 2 have survived ten years. The other 4 have lived from fourteen to twenty-nine months, and their future is of course still uncertain. These and other survival rates are anything but hopeless. The Mayo Clinic in 1940 had 29.3 per cent five year and 18.2 per cent ten year survivals.

Three of Whiteleather's [2] 16 patients (18.7 per cent) were alive in 1945, after the five year period. Some authors have claimed up to 25 per cent five year survivals.

Most investigators have found that nasopharyngeal cancers in the age group under 20 years have a higher degree of invasiveness, also earlier and more metastases that result in early death. Five of the 6 persons living in the group herein reported are between 42 and 52 years of age. Their lesions were all diagnosed fairly early, which again emphasizes the fact that the most important factors in favor of curing nasopharyngeal carcinoma are an early diagnosis and a maximum course of proper irradiation.

SUMMARY

Twelve cases of transitional, squamous or anaplastic cell carcinoma of the nasopharynx, all atypical types, have served as a basis for this discussion.

The most common initial site was the superolateral wall of the nasopharynx.

The four most important early symptoms were cervical adenitis, earache or deafness, hemoptysis and nasal obstruction.

The tumors are radiosensitive and respond best to treatment if an early diagnosis is made.

Irradiation is the treatment universally approved.

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VALUE OF THE CALORIC TEST OF THE LABYRINTH

L. B. W. JONGKEES, M.D.
UTRECHT, NETHERLANDS

THE CALORIC test is an easy way of examining the function of the vestibular organ. The results of the test are used not only in otologic practices, for ascertaining the remainder of function left in cases of labyrinthitis or other labyrinthine deviations, but also in neurologic or otoneurologic practices, for other purposes. Neurologists use the test especially for the examination of the central vestibular organ. Many conclusions are drawn from the caloric test on the function of a labyrinth, such as hyperexcitability and hypoexcitability, or of the central nervous system, such as directional preponderance. But the normal reaction in normal subjects has not been studied seriously until now.

In the opinion of some authors, the caloric reaction shows a pattern, which is called pathologic in normal subjects by most investigators. Streit,[1] in military examinations, often noted a dominance of the reaction of one labyrinth after the caloric test, and Lundberg [2] frequently observed a high percentage of directional preponderance of the same order as that otherwise called pathologic and a dominance of the reaction of one labyrinth. He used water of 27 and 40 C. degrees. Hautant [3] called a labyrinth hypoexcitable when the caloric reaction was shorter than 60 seconds and hyperexcitable when it was longer than 2 minutes. Brunner,[4] on the other hand, made his determination of hypoexcitability or hyperexcitability depend on the time of latency. Not every investigator, however, has such strict standards for determining pathologic excitability. On this subject, Crabbé,[5] in a bibliographic review,

From the Ear, Nose and Throat Department, University of Utrecht (Director, Prof. Dr. A. A. J. van Egmond).

1. Streit, H.: Abweichungen vom normalen Verhalten bei Prüfungen des statischen Apparates und ihre Berücksichtigung für die Beurteilung von Flugzeugführern, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **104:** 56, 1919.

2. Lundberg, N.: On Difference in Vestibular Tone, Acta oto-laryng. **28:** 501, 1940.

3. Hautant, A.: L'étude clinique de l'examen fonctionel de l'appareil vestibulaire, Rev. neurol. **1:**908, 1927.

4. Brunner, H.: Neurology in Otolaryngology, Laryngoscope **53:**117, 1943.

5. Crabbé, F.: Étude critique des techniques d'examen labyrinthique, J. belge de neurol. et de psychiat., September, October, November, 1946.

cautioned against a too hasty acceptance of pathologic excitability of one labyrinth, or even of both.

CALORIC REACTION IN NORMAL SUBJECTS

Normal Reactions.—In order to investigate the reaction of normal subjects to the caloric test, I submitted about 60 medical students who had never had any complaint referable to their ears and who did not show any pathologic deviations in their ear drum to the caloric test, as it is performed in this clinic.

The patient is examined lying on his back, his head flexed on a pillow at an angle of about 30 degrees. Fifty cubic centimeters of water at temperatures of 30 and 44 C. is used, as described in a previous paper.[6] The individual tests are separated by an interval of at least six minutes. As has been shown before, it is not possible to obtain results with a greater accuracy than 10 per cent. For this reason, I concluded that directional preponderance, or dominance of the reaction of one labyrinth over that of the other, existed if the difference in values exceeded 20 per cent. This standard is higher than that of most investigators for considering the condition pathologic. Nevertheless, my associates and I accepted directional preponderance or domination of one labyrinth only if we obtained the same results in at least three separate examinations, preferably of a different kind. We tried chiefly to confirm a pathologic result of the test performed in our usual way, according to the method of Kobrak,[7] with 5 cc. of water of a temperature not differing much from that of the body, then altering this temperature and, by the bilateral method of syringing, giving the caloric stimulus to both ears simultaneously.

We syringed 125 ears with 50 cc. of water of 30 C. degrees. Duration of the nystagmus behind Frenzel's glasses, reckoned from the end of the syringing, when the subject was looking straight ahead, was 140 seconds, on an average, with a variation from 50 to 300 seconds. Thus, it is evident that in a clinical test, even with very long and very short reactions, it is impossible to be sure of the grade of excitability. The excitability of one labyrinth is merely comparable to that of the other. This applies, likewise, to syringing with hot water. We syringed 121 ears with water of 44 C., on exactly the same basis

6. Jongkees, L. B. W.: Which Is the Preferable Method to Perform the Caloric Test? Arch. Otolaryng., to be published.

7. Kobrak, F.: Beiträge zum experimentellen Nystagmus, Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **10**:214, 1918; **11**:244, 1919; Contributions to Functional Pathology of the Ear; Principles of Sensitivity and Efficiency of the Ear, J. Laryng. & Otol. **59**: 171, 1944.

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as that for tests with water of 30 C. Here, as well, a large variation was found, i. e., an average of 112 seconds, with extreme values of 50 and 220 seconds.

Since, from these results, the largest variation appears to occur in normal subjects, it is impossible to describe the duration of nystagmus in caloric tests as being pathologically short or long. If the values found in the aforementioned tests are set out in a graph, the duration in seconds on the ordinate and the number of cases on the abscissa, an almost typical binominal line appears for the reaction to the hot caloric test, whereas the graph diverges largely from the binominal form in presenting the reaction to the cold caloric test (chart 1).

This graph may indicate merely that when the ear is syringed with water at a temperature of 30 C., at least two phenomena with

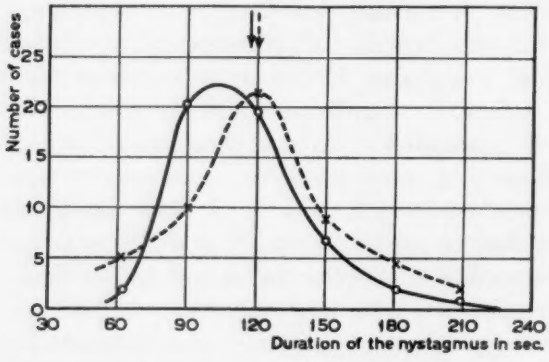

Fig. 1.—The number of cases with a certain duration of nystagmus during the caloric tests is recorded graphically. The dotted line indicates values obtained with water of 44 C.; the plain line, values with water of 30 C. The binominal course of the dotted line and the deviation from the binominal course of the plain line are clear.

a natural binominal spread are cooperating. On the other hand, it seems that the reaction, after the syringing with hot water, is more or less dependent on one natural factor. A possible explanation is either that the influence of vascular reactions is much greater in the case of the cold caloric test or that reflexes from the external auditory canal occur. (In a later paper, I hope to consider the origin of the caloric test.)

We were able to corroborate the statement of Hallpike [8] that on the whole the duration of the nystagmus after the ears were syringed

8. Hallpike, C. S.: The Investigation of Ménière's Disease, J. Laryng. **58:** 349, 1943.

with cold water is greater than after they were syringed with water of a temperature above that of the body. To be exact, we found the reaction to the cold caloric test stronger than that to the hot caloric test in 70 per cent of our subjects; in 10 per cent the reactions after the syringing with cold and with hot water were about equal, and in only 3 per cent did the duration of the reaction to the hot caloric test surpass that to the cold one. In the other patients, the reaction was abnormal. These data are approximately the same as those reported by Hallpike and his co-workers.[9] In general, the strength of the nystagmus after irrigation with hot water was smaller than that after irrigation with cold water.

Abnormal Reactions.—Of 47 (78 per cent) of our 60 subjects there was a normal reaction to the caloric test, i. e., similar durations (within 20 per cent) of the nystagmus from the right and from the left ear on similar stimulation. Of the other 13 subjects, however, there was a different reaction. Of these 60 subjects, there was a dominance of one labyrinth in 3 cases (5 per cent)—in 1, of the right labyrinth and in 2, of the left one. In these subjects the duration of the nystagmus after stimulation of one labyrinth was longer for both hot and cold water.

As already mentioned, a dominance was accepted only if the reaction of one labyrinth exceeded that of the other by at least 20 per cent. Of the 3 subjects, 1 had a family with many cases of otosclerosis and Ménière's disease, another had asthma and other allergic diseases, and the last was apparently normal. Thus, dominance of the caloric reaction of one labyrinth over the other is extremely rare in normal subjects. In comparison with the results obtained in patients with Ménière's disease, as given by several authors, the difference is evident.

In cases of Ménière's disease, de Kleyn and Versteegh[10] noted a difference in the reaction of the two labyrinths in 73 per cent, and Hallpike,[8] in about 50 per cent. Though these authors did not state at which percentage they accept a dominance, it is clear that in the caloric test a dominance of the function of one labyrinth over the other is highly suggestive of a pathologic condition.

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9. Cawthorne, T. E.; Fitzgerald, G., and Hallpike, C. S.: Observations on the Directional Preponderance of Caloric Nystagmus Resulting from Unilateral Labyrinthectomy, Brain **65:** 138, 1942.

10. de Kleyn, A., and Versteegh, C.: (*a*) Some Remarks on the Present Position of the Physiology of the Labyrinth, J. Laryng. & Otol. **42:**649, 1927; (*b*) Ueber verschiedene Formen von Ménières Syndrome, Deutsche Ztschr. f. Nervenh. **132:** 157, 1933.

The caloric test may give another issue, which in general is not accepted as normal. In such cases a directional preponderance of the nystagmus is found; this means that the nystagmus in one direction is more easily stimulated than that in the other. For instance, a directional preponderance to the left is present if the duration of the reaction of the right ear to the cold caloric test is stronger than that of the left ear, and if at the same time the reaction of the left ear to the hot caloric test is the stronger. The nystagmus to the left seems to have some readiness (*Nystagmusbereitschaft*) to appear. It is regrettable that the word *Nystagmusbereitschaft* has a double meaning. Kobrak,[7] who first used it, intended it to mean that a nystagmus might be caused more easily if a preliminary stimulus were given. With this meaning of the term, *Nystagmusbereitschaft* and "directional preponderance" are entirely dissimilar. Later, Dusser de Barenne and de Kleyn [11] observed the phenomenon of directional preponderance, which they named *Nystagmusbereitschaft* also, when one hemisphere of the cerebrum of rabbits was removed and the nystagmus was directed toward the part of the brain operated on. After this first communication, many others on the clinical use of this phenomenon followed—by de Kleyn and Versteegh [10] Barbey and de Morsier [12] Fitzgerald and Hallpike [13] and Brunner.[4]

The predominance of nystagmus in one direction occurs in a high percentage of cases of cerebral lesions. Tumors of the temporal lobe often cause directional preponderance toward the lesion. Fitzgerald and Hallpike,[13] Bruner [4] and de Kleyn and Versteegh [10b] stated reasons for their belief that a nystagmus caused by syringing of the ears simultaneously with cold or warm water is suggestive of a pathologic process in the posterior cranial fossa. On irrigation with cold and hot water, the nystagmus is in the same direction. If the directional preponderance is observed merely in the monaural test, a pathologic process in the anterior cranial fossa is suggested.

In my series of experiments, a directional preponderance in the caloric test was found in 10 cases (16.6 per cent). The directional

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11. Dusser de Barenne, J. G., and de Kleyn, A.: Vestibulaire oogreflexen bij konijnen na eenzijdig wegnemen van de grote hersenen, read before the Nederlandsche Keel-Neus,-oorheelkundige Vereeniging, November 1919; Ueber vestibuläre Augenreflexe: V. Vestibularuntersuchungen nach Ausschaltung einer Grosshirnhemisphäre beim Kaninchen, Arch. f. Ophth. **111:** 374, 1923.

12. Barbey, E., and de Morsier, G.: La prédominance unilatérale de la direction du nystagmus provoqué, Ann. d'oto-laryng., 1938, p. 46.

13. Fitzgerald, G., and Hallpike, C. S.: Observations on the Directional Preponderance of Caloric Nystagmus, Brain **65:** 115, 1942.

preponderance was to the right in 2 cases and to the left in 8 cases, i. e., in about 3 and 13 per cent. A directional preponderance was accepted only if the nystagmus in one direction surpassed that in the other by at least 20 per cent. But I was not satisfied with this criterion and required the same result in at least three separate tests performed in different ways.

In each of these 10 cases, the directional preponderance was shown in the method previously described and in the examination performed according to Kobrak. The directional preponderance may exist for three indicators: the duration, the sensation and the frequency of the nystagmus. All three of these indicators were present in these 10 subjects, who were also tested by simultaneous irrigation of the ears. The result was not conclusive; for about half the subjects the simultaneous test showed directional preponderance as well; the reactions of the other half of the subjects were negative. We no longer got a unanimous result from the cupulogram, but in 4 of the 6 subjects who were submitted to the turning test a clear directional preponderance was noted (van Egmond, Groen and Jongkees [14]). That a directional preponderance to the left occurred more frequently than that to the right is remarkable, the more so when it is considered that 1 of the subjects with directional preponderance to the right was left handed. Another left-handed subject in this series showed a directional preponderance to the right as well, but this was of the order only of 10 per cent, and his case is therefore not included in the group of 10. A possible explanation of the directional preponderance in normal persons may be sought in the predominance of one hemisphere of the brain, known to be the origin of normal right handedness. I do not mention this as a positive explanation, especially as it does not agree with the results of the experiments of Dusser de Barenne and de Kleyn [11] on rabbits. The destruction of one hemisphere of the brain gives a directional preponderance toward the damaged side. The directional preponderance to the left should indicate a predominance of the activity of the right hemisphere if the same data are valid for normal persons. Nothing is known on this subject. In normal persons a dominance of the left hemisphere is accepted (compare Broca's center for speech).

The occurrence of a directional preponderance in 17 per cent of this series corroborates exceptionally well the experiments of others. De Kleyn and Versteegh [10a] found directional preponderance in 17 per cent, Hallpike,[8] in 21 per cent and van Deinse,[15] in 22 per cent.

14. van Egmond, A. A. J.; Groen, J. J., and Jongkees, L. B. W.: Cupulometrie, read before the Nederlandsche Keel-Neus,-oorheelkundige Vereeniging, November 1946.

15. van Deinse, J. B.: Het Ménière-Syndroom, Thesis, Amsterdam, 1946.

These investigators, however, examined patients with Ménière's disease, whereas I examined normal subjects. This should be sufficient reason to mistrust the pathologic interpretation of the directional preponderance found in persons with Ménière's disease. It indicates that one must be careful in drawing conclusions from the single finding of a directional preponderance, especially if it is to the left in right-handed persons, or to the right in left-handed persons. Although we do not agree with Lundberg's [2] percentages for the variations in the caloric test, a result which may be explained by the percentage which he required for the admission of a directional preponderance, we corroborate his statement that directional preponderance is found in many normal subjects. The hypotheses of the various workers on the origin of directional preponderance are far from similar. Most of them accept some dominance of one side of the central nervous system over the other side, a theory which is made very attractive by the experiments of Dusser de Barenne and de Kleyn.[11a]

Brunner [4] maintained that the origin is in the brain stem; van Deinse,[15] of de Kleyn's clinic, contended that the directional preponderance is due to vascular phenomena. On the other hand, it was Hallpike's [8] expressed opinion that the origin of the predominance should be sought in the utricle, as it is a tonic effect and the utricle is the cause of tonic activity in the labyrinth. As was pointed out in another paper (Jongkees and Groen [16]), the differentiation of tonic and dynamic stimuli, both perceived by different sense organs, was based on apparent, but not real, mechanical phenomena, a theoretic mistake. Moreover, an influence of the utricles on nystagmus, especially on its duration, has neither been observed nor made probable. This does not make the hypothesis of Hallpike very attractive. On the other hand, we have the impression, based on experiments which follow, that in this matter the influence of vasoconstriction and vasodilatation is great.

VASCULAR INFLUENCE

The duration of the nystagmus varies with different positions of the subject; when the body is in the upside down position, in such a manner that it is bent forward 120 degrees, the nystagmus is generally shorter than when the body is in the normal position and is directed to the other side.

The duration of the nystagmus with the patient in the upside down position, fastened to the position chair of Quix, is not easily observed, for various reasons. Observation is difficult unless the observer makes

16. Jongkees, L. B. W., and Groen, J. J.: The Nature of the Vestibular Stimulus, J. Laryng. & Otol. **61**: 529, 1946.

use of a mirror, but use of this device leads to other difficulties. The subject's position is inconvenient; congestion develops; he moves uneasily, closes his eyes or has an irresistible inclination to move them. Nevertheless, I have always found a clear reversal of the nystagmus in this position, as compared with that when the body is in the normal position, and Eckert [17] made the same observation. Blumenthal,[18] however, stated that the reversal of the nystagmus is usually not complete (?), and Lanos [19] often found no reversal at all. The cause of the discrepancy in these results may perhaps be sought in the fact that Blumenthal and Lanos examined subjects with a labyrinth merely apparently reacting, and that syringing with hot water would not have given a reversal.

With the body in the reversed position, the difference in the duration of the reactions after irrigations with cold and hot water is almost absent. In chart 2, the data of about 50 tests are presented. Again, in these cases, the character of the line for the reaction to the hot caloric test is a real binominal one, the graph for the reaction to the cold caloric test being nonbinominal. This time the deviation of the curve is pointed toward a shorter duration. This might suggest that the influence of the reaction to the cold caloric test with the subject in the normal and in the reversed position adds a second factor to the basic one, the reason for the reaction to the water being similar. This factor gives a prolongation of the contralateral or a shortening of the homolateral nystagmus. It is not improbable that this is a vascular effect or is due to reflex activity from the external auditory canal, as a vestibular origin seems very unlikely.

In the subjects examined in this way, the directional preponderance was also found if they were tested in the upside down position, but in all instances the preponderance was not so clear as when they were in the normal position. According to the theory of Bárány,[20] which is the most generally accepted as an explanation of the caloric reaction, the difference in temperature between two points of the horizontal canal

17. Eckert, A.: Ist der Nystagmus bei kalorischen Schwach- und Starkreizen physikalisch oder physiologisch bedingt? Ztschr. f. Hals-, Nasen- u. Ohrenh. **2**: 165, 1922.

18. Blumenthal, A.: Zur Erklärung des kalorischen Nystagmus, Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **20**:307, 1923-1924.

19. Lanos, M.: Contribution a l'étude du nystagmus calorique, Thesis, Paris, no. 38, 1925.

20. Bárány, R.: Untersuchungen über den vom Vestibularapparat des Ohres reflektorisch ausgelösten rhythmischen Nystagmus und seine Begleiterscheinungen, Monatsschr. f. Ohrenh. **40**:193-297, 1906.

is the cause of a stream of endolymph; this stream causes the reactions perceived in the caloric test.

When the test is performed with the patient in the reversed position, the direction of the stream is opposite that occurring when he is in the normal position. If the stream of endolymph were the only reason for the caloric reaction, there might be no cause for a difference in the character of the reaction, in the two positions, as they are similar, though reversed. The cause of the deviations must be sought elsewhere. An often accepted theory is the influence of otoliths; another is the influence of vascular activity. With the subject in the reversed position, the blood is driven toward the head, and hyperemia is clearly visible. Therefore, the same influence on the blood vessels as that in the hot caloric test is to be expected, and this might be the cause of the variation.

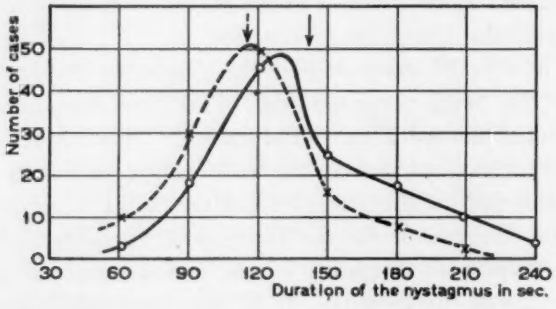

Fig. 2.—The number of cases with a certain duration of nystagmus during the caloric test is recorded graphically. The dotted line indicates values obtained with water of 44 C.; the plain line values with water of 30 C. The tests were performed with the subject in the upside down position. The binominal character of the dotted line and the deviation of the plain line are clear.

I tried to verify this assumption by examining the subjects in a similar position with respect to the vascular influence, but in a dissimilar one with regard to the otoliths. The subject was placed on the position chair, which was tilted backward at an angle of 120 degrees, with his face turned upward. The result of the caloric test performed with the subject in this position was the same as that with the subject in the normal position (with the chair tilted backward at an angle of 60 degrees). At first sight this result would seem to contradict a vascular influence, as the same result should be expected as with the subject in the upside-down position. However, the otoliths are also in a position other than the normal one, and the result is the same, but the vascular influence is by no means the same. The backward position is more easily maintained by the subject than the forward one. The excess flow of blood to the head is less clearly visible in

the latter position, as are the other objective symptoms of the vascular reaction with the variation in the position. Most subjects easily maintain the backward position at an angle of 120 degrees for a long time, but almost everyone becomes extremely tired in the forward position in about five minutes. Therefore, I do not consider the factors in the experiment sufficiently clearcut to enable one to settle the problem of the vascular influence.

There is another experiment, however, which might be helpful in its solution. The vasodilatory effect of amyl nitrite is well known, and this drug is often used therapeutically. When a subject inhales a few drops of it, he shows the symptoms of strong vasodilatation after a few seconds: His face grows red; he becomes very warm, and, if the inhalation is not stopped, a headache accompanies the other phenomena. The acceleration of the pulse rate is an objective symptom indicating when the activity of the amyl nitrite should be controlled. As the inhalation of this drug is not pleasant, I had no opportunity to examine many subjects, but the results of the use of the drug in the 4 patients whom we were able to examine thoroughly were exactly the same.

The test was performed as follows: First, the normal caloric reaction in both ears was measured with cold and hot water; after that the subject remained in the same position and inhaled a few drops of amyl nitrite from a piece of gauze. He continued this until the end of the syringing, which was started as soon as a clear reaction was visible. After a pause of a few minutes, the other ear was syringed as soon as the effect of a new inhalation was visible; then both ears were examined once more with water of the same temperature as that used after inhalation. Before inhalation, the caloric reaction of 3 of the 4 subjects was completely normal, the duration of the reaction to the cold irrigation being longer than that to the hot one. After inhalation, the duration was similar for both hot and cold irrigation, and the same as the reaction to the hot water irrigation before inhalation.

The influence of the vasodilatation on the time of latency and the frequency of the nystagmus seems to be nil, but the nystagmus is stronger and more easily measured, because it starts and stops very abruptly. The subject's sensation of turning around, caused by the irrigation, seems likewise to be unaffected, but the sensibility of the external auditory canal is greater, so that the irrigation becomes more disagreeable than during the normal condition. Especially the syringing with hot water at a temperature of 44 C. is considered decidedly painful.

The fourth subject had a directional preponderance to the left. After inhalation of the drug, this no longer occurred in the nystagmus

or in other sensations. The frequency of the nystagmus merely indicated some directional preponderance, as the one to the left was greater than that to the right for both ears. The duration of each of the four kinds of nystagmus was of equal length and was as long as the nystagmus to the right in the experiments previous to the inhalation of the amyl nitrite (chart 3).

The effect of 1.6 mg. of glyceryl trinitrate given to melt under the tongue was the same in principle but was not so strong as that of the amyl nitrite.

I believe that these experiments prove not only that the caloric stimuli have an influence on the vessels, but also that the vasodilatation of the blood vessels has an effect on the duration of the nystagmus. Moreover, the influence of the vasodilatation on the nystagmus seems to be slight in the reaction to the hot caloric test; on

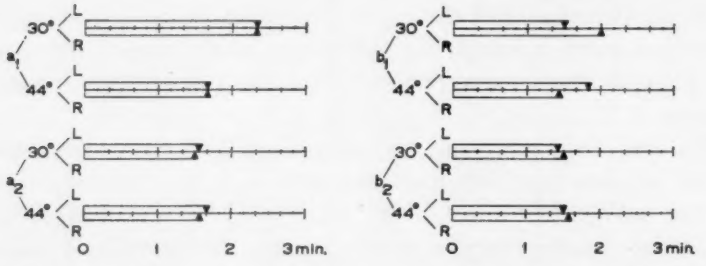

Fig. 3.—The diagram, after Hallpike,[8] is used to indicate the influence of the inhalation of amyl nitrite on the caloric reaction of a subject with a normal reaction and of a subject with a directional preponderance, both subjects being normal. The upper figure gives the normal values; normal reaction and directional preponderance to the left; the lower figure, the effect of the inhalation of amyl nitrite.

the other hand, it is strong in the reaction to the cold caloric test. This is the same with respect to the reversal of the subject's position: The reaction to the hot caloric test is almost unaffected. This suggests that the deviation from the normal Gauss binominal curve of the cold caloric test is caused at least partly by vascular influences.

This is easily understood if it is kept in mind that under the influence of stimulation with hot water the vessels widen and, in consequence, are no longer affected by the similar dilating effect of the described experiments. On the contrary, the effect of stimulation with cold water is exactly counteracted in its action on the vessels, and it seems that the dilating influence on the vessels prevails.

The function of the blood vessels in the caloric test has been mentioned many times. According to Blumenthal,[18] the injection of epinephrine U. S. P. should suppress the caloric reaction almost entirely.

Experiments on the sympathetic nerve fibers and their ganglions in the neck induced many investigators (Terracol,[21] Grahe,[22] Borries[23] and Montandon[24]) to accept the concept of vascular influences on the caloric test.

INFLUENCE OF THE SENSIBILITY OF THE EXTERNAL AUDITORY CANAL

That the sensibility of the external auditory canal is capable of causing nystagmus is another factor considered by many authors as influencing the caloric reaction. This is the reason that de Kleyn,[25] for instance, always required a normal reaction to the cold, as well as to the hot, caloric test before he declared the vestibular reaction to be intact (Urbanschitsch[26]).

To obtain an impression of the influence of the sensitivity of the external auditory canal, I performed the test before and after anesthetizing that canal by injecting several cubic centimeters of 2 per cent solution of procaine hydrochloride around the wall of the auditory canal, in front and in back, similar to the performance of a Schwartze operation with local anesthesia.

The effect of the anethesia was a complete insensibility of the external auditory canal to touch and caloric sensations. Unfortunately, it was possible to perform this experiment only on 3 patients with Ménière's disease, and not on any normal subject. Nevertheless, in 2 of the 3 subjects, the influence of the sensibility of the external auditory canal was unmistakable, not only when the test was performed on the side of injection, but also when performed on the other side. In chart 4 are indicated the results of this test before and after anesthesia was given. As can be seen in chart 4, in *a* and *c*, for the left ear, and in *b*, for the right ear, the influence is obvious, but cannot easily be

21. Terracol, F.: Nystagmus et sympathique cervical, Rev. d'oto-neuro-ocul. **5**: 953, 1927.

22. Grahe, K.: Die Vertikalempfindung auf dem "Vestibular" Tische bei kalorischer Reizung des normalen und labyrinthlosen Ohres und des Halses, ein Beitrag zur Frage der "Vestibularreactionen" bei fehlendem Labyrinth, Acta oto-laryng. **11**: 158, 1927.

23. Borries, G. V.: Theorie des kalorischen Nystagmus, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **113**: 117, 1925.

24. Montandon, A.: Le labyrinth et le système nerveux végétatif, Pract. oto-rhino-laryng. **7**:285, 1945.

25. de Kleyn, A.: Some Remarks on Vestibular Nystagmus, Confinia neurol. **2**: 257, 1939.

26. Urbanschitsch, E.: Nystagmus gegen die gleichnamige Seite, usw., Monatsschr. f. Ohrenh. **51**:56, 1917.

forced into a system. In *b* and *c* it is shown that the reaction of the other ear is influenced by the anesthesia of one auditory canal. This, however, did not cause a directional preponderance, although the reaction to the hot caloric test in *b* was prolonged. This does not seem to corroborate the hypothesis of Cawthorne, Fitzgerald and Hallpike [9] that labyrinthectomy for vertigo and tinnitus from Ménière's disease causes directional preponderance; after this, the caloric reaction of the other ear may change—the reaction to the cold caloric test, which was the stronger, becoming the weaker. As is shown in our experiments, this may also happen without the existence of a directional preponderance after a single injection of procaine hydrochloride into the wall of the auditory canal.

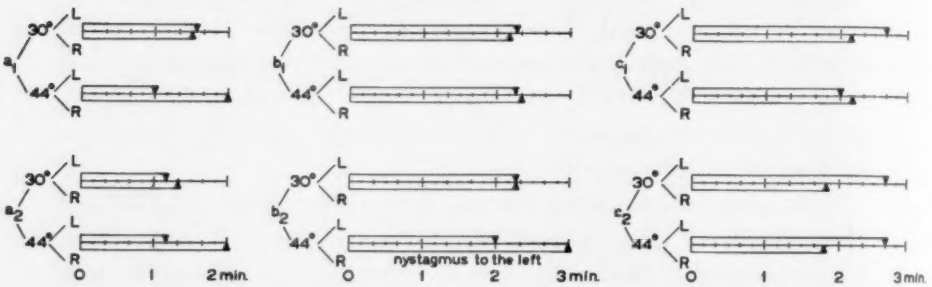

Fig. 4.—The caloric reaction is plotted after Hallpike [8] for both ears in the tests with the water at 30 and 44 C. The upper graphs indicate the results of the test for the 3 patients in normal condition; the lower graphs, corresponding values after one external auditory canal was anesthetized (in the left ear in *a* and *c*, in the right ear in *b*).

The effect is clear enough, but the explanation of its origin is quite a different matter. That the sensibility of the external auditory canal is destroyed is not the only effect. The influence on the vessels of epinephrine, as well as that of procaine hydrochloride, is strongly vasoconstricting. The influence of the injection of epinephrine on the caloric reaction of the heterolateral ear definitely suggests a vascular effect. The fact that the result is essentially the reverse of the action of vasodilation supports this suggestion, as the reaction to the hot caloric test is more affected than that to the cold one. If such a small number of experiments may suggest anything, it can be supposed that a sensible reflex of the auditory canal has its effect with the assistance of vascular phenomena.

Without our going into the subject further, as we hope to publish the results in due time, the measurement of the temperature at the drum membrane has value for the establishment of the importance of the caloric test. These experiments, performed with the help of

J. Groen, showed clearly that the duration of the nystagmus in normal subjects was of the same order as that of the change of temperature at the drum membrane. This corroborates the conception of Lorente de Nó [27] that the caloric nystagmus is of the same duration as the influence of the stimulus.

The normal duration of the nystagmus and its time of latency noted in our subjects agree with the values given by Meurman [28] and Dohlman.[29]

As I have emphasized in a previous paper, the duration of the caloric nystagmus is highly independent of the quantity of water and only moderately dependent on its temperature. Material on the same phenomenon appears in a paper by Dohlman,[29] with regard to the fluctuations of the temperature in a temporal bone of a dead body when the caloric test was performed in the usual way. Thus, it appears that the duration of the caloric reaction is highly dependent on the flux of temperature in the labyrinth and so on the anatomic structure of the temporal bone. If both ears are syringed simultaneously, and if the stimuli are identical, practically no nystagmus is produced. But even in normal subjects, without a dominance of the function of one labyrinth, or without a directional preponderance, a nystagmus of the second degree is sometimes found. This should be attributed to a difference in the structure of the bone on the two sides (de Kleyn [30]).

SUMMARY AND CONCLUSIONS

This paper deals with the determination of the value of the caloric test in otologic and in neurologic practice with the aid of experiments on a number of normal subjects. First, I point out that the variations in the duration of caloric nystagmus are such that hypoexcitability or hyperexcitability of the labyrinth may not be accepted on the basis of an apparently long or short duration of the nystagmus. For normal subjects the spread is such that, with the same technic, values of 50 and 300 seconds are both within the normal range. That the duration of the nystagmus is the sole, proper indicator of the caloric nystagmus has already been revealed in a previous paper.[6]

27. Lorente de Nó, R.: Einiges zur Labyrinthphysiologie, Acta oto-laryng. **11**: 301, 1927.

28. Meurman, Y.: Experimental Investigations on Conduction of Warmth to the Labyrinth of the Ear and to the Caloric Nystagmus, Acta oto-laryng. **6**: 555, 1924.

29. Dohlman, G.: Physikalische und physiologische Studien zur Theorie des kalorischen Nystagmus, Acta oto-laryng., 1925, supp. 5, p. 1.

30. de Kleyn, A.: Rapport sur les moyens d'exploration clinique de l'appareil vestibulaire, Rev. neurol. **1**: 888, 1927.

The presence of directional preponderance, especially to the left, is not a pathologic sign in itself, as it occurs in about 20 per cent of normal persons.

The influence on the caloric reaction of the factors of vascular activity and sensibility of the external auditory canal is investigated experimentally.

Some factors are indicated, based on experiments with the same normal subjects, which suggest that vascular activity has a great influence on the caloric test.

Measurement of the temperature at the tympanic membrane during the caloric test leads to the probable conclusion that the duration of the nystagmus is dependent on only the change of temperature in the peripheral sense organ, i. e., the vestibular labyrinth.

Without being as pessimistic as Fischer,[31] who declared that ". . . in my opinion the nystagmus following the irrigation of one ear cannot give any clear view of the process of calorization," I am sure that it is preferable not to be too optimistic about the value of the caloric test.

Only a difference in excitability of a certain degree between the two labyrinths is suggestive of a pathologic deviation; likewise, the absence of any caloric reaction is important.

The symptom of directional preponderance should be considered with the utmost caution. I agree with every word of the statement of Montandon [24] (page 330):

> Notwithstanding the valuable information which it may give daily in the clinic, and the many improvements in its technic, the caloric stimulation of the vestibular organ is not specific and remains a source of errors, a fact which should not be overlooked.

The caloric test is by no means comparable to the use of a physical measuring instrument such as a voltmeter; rather, the caloric test may be compared to the use of an electric current in testing the measuring instrument, and not to the use of the instrument in testing the current. Thus, the answer is the same as that when a voltmeter is tested with an electric current; one obtains an impression of its functioning—whether it is normal, below normal, as compared with another instrument, or out of order. If no more is expected of it, the caloric test will provide precious information on the functioning of the labyrinth. But if more is desired, the test is not capable of satisfying, and sooner or later it will be disappointing. Comparison of the caloric test to a physical measuring instrument is not merely

31. Fischer, M. H.: Beiträge zur Physiologie des menschlichen Vestibularapparates: V. Bilateral Methoden, speziell Doppelspülungen, Arch. f. d. ges. Physiol. **213**:74, 1926.

an abstraction; it is based on reality. The measurement of the temperature and its course during the caloric test indicate that in observing any caloric reaction one can measure only the flux of heat through the temporal bone and the influence of that flux on the vestibular organ. Finally, even this measurement is inconvenienced by vascular and accessory factors.

The value of the caloric test of the labyrinth should not be overestimated. The spread of the duration of the caloric reaction in normal subjects makes impossible conclusions concerning the excitability of a labyrinth from the duration of the nystagmus.

In a high percentage of normal subjects, abnormal reactions are found: dominance of function of one labyrinth in 5 per cent and directional preponderance in 17 per cent.

The caloric test, even if it is performed perfectly, has restricted value. It may teach something about the function of the labyrinth—whether it is apparently normal, subnormal or destroyed.

Any other conclusion, concerning directional preponderance, for instance, should be made with the utmost caution.

Catharijne sirgel 101.

STREPTOMYCIN BY TOPICAL APPLICATION IN TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA

A. E. LUNDON, M.D.
MONTREAL, CANADA

BECAUSE of the comparatively short time that streptomycin has been made available for clinical use in subduing infections of special otologic interest, except in very selected cases, it is not surprising that there is very little current literature available on the topical application of this antibiotic in cases of chronic suppurative otitis media.

One of the most comprehensive reviews published in recent years on otitis media (Dysart [1]) provided an extensive bibliography, covered the literature for 1945 and, as might be expected, contained no mention of the use of streptomycin topically, or in any other manner, in the treatment of otologic infections. Little of interest is found in this connection until the literature is reviewed for 1947. Several publications are of special interest with regard to the treatment of chronic suppurative otitis media.

REVIEW OF LITERATURE

Callum,[2] whose valuable contribution was not intended to bear on the use of the antibiotics, supplied interesting and alarming statistical information, which was presented almost as an apology for a paper with the timeworn title of "Chronic Purulent Otitis Media." He dramatically pointed out that this condition has been a scourge since the time of Hippocrates and described it aptly as "a disabling, crippling, disgusting and death-dealing disease," and he estimated that in at least 20 per cent of all such cases the disease is given up as incurable by conscientious otologists. Estimates indicating its prevalence were supplied, and his figures are so disquieting as to be worthy of brief repetition here. Of a group of 1,000 school children examined in England, it was found that 8.8 per cent had this disease. In 1919, estimates for the United States Army showed an incidence of chronic suppurative otitis media of 5.2 per thousand for officers and of 12.23 per thousand for men of other ranks. Callum further pointed out

1. Dysart, B. R.: Otitis Media and Complications: Summaries of Bibliographic Material in Field of Otolaryngology, Arch. Otolaryng. **45**:594 (May) 1947.

2. Callum, M. M.: Chronic Purulent Otitis Media, Arch. Otolaryng. **46**:137 (Aug.) 1947.

that the disease is found in about 2 per cent of the population and that there are 2,800,000 cases of this disease in the United States. Other authors have placed this estimate as high as 5,600,000. Deaths due to intracranial complications were mentioned by Callum, and the picture of persons who continue to live "deafened by the distressing ravages of the disease" was presented adequately. Weight was given to the expression of his opinion that in the majority of cases of chronic suppurative otitis media the disease is secondary to chronic purulent sinusitis present on the same side as the aural infection, and the treatment recommended, that of surgical drainage of the accessory nasal sinus, was supported by case reports. In treatment of patients with intractable chronic suppurative otitis media, referred to later in this article, the principles enunciated by Callum were observed.

Pulaski and Matthews [3] presented 11 cases of chronic suppurative otitis media which was treated by the topical application of streptomycin. Four of these were cases of infection following mastoidectomy. The organisms in all these cases were not subjected to sensitivity tests, but in 4 instances treatment was followed by a change in the quantity and character of the discharge—from copious purulent to minimal serous—and healthy granulations appeared. However, of the 7 remaining cases, improvement occurred in 6, and no benefit was noted in 1 case. In the 6 cases in which improvement occurred, suppuration ceased; a dry perforation persisted in 4 of the 6 cases, and in 2 cases a slight discharge continued and was controlled later by treatment formerly found ineffective (2 per cent acetic acid).

It must be noted, however, that in the treatment in these cases, routine "cleansing of the cavities by syringing was employed before streptomycin solution was introduced." The authors further stated that "the clean and swabbed-out canal was usually flooded with the antibiotic and that the process was repeated one to three times daily." Presumably, therefore, this group of patients was treated as inpatients, as it would not seem practical to treat outpatients in this manner. Special attention is therefore directed to the technic employed, as the group of patients referred to later in this report was composed exclusively of men who attended for treatment as outpatients and carried on with their civilian vocations with little loss of time while under treatment.

Holt and Snell [4] presented a report on a total of 20 patients treated with streptomycin administered topically and intramuscularly. In only 10

3. Pulaski, E. J., and Matthews, C. S.: Streptomycin in Surgical Infections, Arch. Otolaryng. **45**:503 (May) 1947.

4. Holt, J. B., and Snell, F. B.: Streptomycin Used in the Treatment of Suppurative Otitis Media, Arch. Otolaryng. **45**:169 (Feb.) 1947.

of these patients was the condition chronic; in the others, it was acute. All the patients were hospitalized and therefore do not represent a group comparable to the group presented in this report, who were strictly outpatients and did not receive intramuscular therapy. It is of interest, however, that complete cessation of suppuration of the middle ear was obtained in 50 per cent of the total series of Holt and Snell.

While removed from the field of antibiotics, a recent publication is of interest in reviewing methods for the treatment of this condition. Brown and Owen,[5] in using hydrogen peroxide (1.5 per cent) derived from urea peroxide in glycerin, obtained impressive results. Middle-aged patients with chronic suppurative otitis media of lifelong duration, with profuse fetid discharge, had dry ears after short periods of this treatment. Of the 37 patients treated, 29 were completely relieved of their chronic infection after periods of treatment ranging from four to thirty-eight days. Such results have probably not previously been recorded, and the therapy described seems worthy of special consideration.

PRESENT STUDY

Early in 1946, Dr. W. P. Warner, director general of treatment services for the Department of Veterans' Affairs, Canada, arranged that streptomycin be made available to Queen Mary Veterans' Hospital, Montreal, for treatment of selected patients; and, through the cooperation of Dr. D. H. Starkey, Dr. C. M. Gardner and Dr. W. H. P. Hill, directors of the laboratories and the departments of surgery and medicine, respectively, of this hospital, streptomycin was made available to otolaryngologic outpatients, on application in specific cases.

The treatment of 20 veterans, outpatients of Queen Mary Veterans' Hospital, during the period from Feb. 1, 1947, to March 1, 1948 is presented. All were afflicted with chronic suppurative otitis media, and all but 2 had resisted ordinary forms of treatment, given over long periods, including the use of sulfonamide drugs, penicillin and alcoholic preparations. Conditions common to all the patients are summarized as follows:

1. All patients had chronic suppurative otitis media, and some had a history of mastoidectomy.

2. All were white men within military age except 3, veterans of World War I, who were in their middle fifties.

3. Streptomycin in saline solution was used, each cubic centimeter containing 5,000 micrograms. Each patient was supplied with 25 cc. (125,000 micrograms) for each two week period of treatment and for each ear under treatment.

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5. Brown, E. A., and Owen, W. E.: Treatment of Chronic Purulent Otitis Media with Glycerite of Hydrogen Peroxide, Arch. Otolaryng. **43**:605 (June) 1946.

4. Organisms were identified and sensitivity tests were completed in all cases. Only patients showing invading organisms with sensitivity to streptomycin were treated.

5. Because of the extreme necessity for economy in the use of this drug, when treatment of this series was begun, all patients were given penicillin (5,000 units per cubic centimeter) for topical use at home, at the time that specimens were taken for bacteriologic examination. They used the penicillin at home for two weeks; this routine provided not only the time necessary for the completion of bacteriologic study, with special reference to sensitivity tests, but also the opportunity to eliminate certain gram-positive organisms before streptomycin treatment was begun. In no single instance did the use of penicillin alone in these chronic cases bring about resolution, conforming to the observation of Loeb,[6] whose results in the treatment of suppurative otitis media with various preparations (streptomycin not included) indicated that penicillin topically applied is of little or no value in chronic cases.

6. All patients were instructed to keep the streptomycin at home, at refrigeration temperature, and to avoid its contamination, to boil the glass droppers for five minutes before use and to use, on each occasion, about 1 inch (2.5 cm.) of the solution in the dropper (about 1 cc.) for a period of two weeks.

7. They were also instructed to carry out this procedure twice daily, when at all possible, and to allow the solution to remain in the affected ear each time as long as possible—"at least half an hour, and if possible to go to sleep with it in the ear."

8. Irrigation of the ears was seldom undertaken. Generally, the middle ear and the external canal were cleared of purulent secretion and detritus by means of swabbing and the use of gentle suction with Siegel's speculum. To minimize secondary infection, the swabs and applicators used were autoclaved and the ear speculum was boiled for each patient.

9. Roentgenograms of the accessory sinuses were obtained whenever the history and clinical findings indicated the possibility of existing sinus involvement. However, patients on whom sinus operations were performed and who were subsequently given streptomycin therapy do not appear among those treated successfully.

10. On completion of treatment, favorable or otherwise, patients requiring an accurate estimation of hearing loss for the adjudication of disability claims or those who might benefit from a hearing aid were referred to the audiometric department for calculation of the percentage loss for speech, for the recording of speech-effective thresholds, as measured through the use of the monitored human voice (live voice), and, when indicated, for open field tests and the comparison of various approved types of hearing aids.

REPORT OF CASES

CASE 1.—There was a history of chronic suppurative otitis media of the right ear of four years' duration, a persistent discharge of purulent secretion since simple mastoidectomy in 1943 and an offensive purulent secretion coming through a perforation of the anterior inferior quadrant of the tympanic membrane. Bacteriologic examination on Aug. 1, 1947 revealed a heavy growth of Aerobacter aerogenes sensitive to streptomycin in a strength of 30 units per cubic centimeter. Treatment began on August 30. On September 10 the right ear

6. Loeb, W. J.: Penicillin Ear Drops in Treatment of Suppurative Otitis Media, Arch. Otolaryng. **43**:586 (June) 1946.

had less discharge and no odor. Bacterial culture of material taken on September 15 yielded no growth after four days' incubation. On September 22 there was no longer a perforation of the tympanic membrane, but there was a high perforation of the attic with a small amount of blood-stained discharge. Bacteriologic study on September 26 showed a moderate growth of A. aerogenes sensitive to streptomycin in a concentration of 10 units per cubic centimeter— practically the same sensitivity as that reported on August 1, with a more sensitive strain. Treatment with streptomycin was again undertaken. Bacteriologic study on October 24 showed the same organism with sensitivity to 50 units per cubic centimeter. Roentgenologic examination of the sinuses on October 29 revealed no abnormality, and examination then showed that the right tympanic membrane was intact, with no evidence of suppuration. Bacteriologic examination on November 5 showed a light growth of A. aerogenes sensitive to streptomycin in a concentration of 50 units per cubic centimeter. The patient was referred for audiograms.

CASE 2.—There was a history of persistent discharge from both ears, from the left for eight years and from the right for five years, together with a history of many local treatments with sulfonamide powders and solutions of penicillin. The patient complained of pain over the left mastoid region, loss of weight and a feeling of general unwellness. Examination showed bilateral chronic suppurative otitis media, with perforation of the posterior inferior quadrant of the left tympanic membrane and a central perforation of the right membrane. Examination of the nose and throat, including roentgenograms of the sinuses and mastoid, revealed nothing significantly abnormal. Bacteriologic examination on October 31 showed the presence of Proteus intermedius in both ears; that isolated from the left ear was sensitive to streptomycin in a strength of 100 units per cubic centimeter and that from the right ear in a strength of 50 units per cubic centimeter. Therapy was started on that date, and by November 10 the right ear was dry and there was minimal discharge from the left ear. On bacteriologic study on November 28 P. intermedius, sensitive to streptomycin in a strength of 20 units per cubic centimeter, was isolated from the left ear; on December 8 both ears were dry, and there was a small central perforation of the right tympanic membrane and a perforation of the posterior inferior quadrant of the left tympanic membrane (with a notation on the record that "both may close"). The patient was referred for audiographic study.

CASE 3.—There was a history of mastoidectomy on the right side in 1943, following explosive blast trauma. Examination showed a large perforation in the posterior inferior quadrant of the left tympanic membrane, with the rest of the membrane showing extensive opacity. The pars tensa of the right tympanic membrane was destroyed, but the inner wall of the right middle ear was healthy. A blood-stained discharge with visible pulsation was noted on January 20. Bacteriologic study on January 27 revealed a moderate growth of Achromobacter sensitive to streptomycin in a strength of 500 units per cubic centimeter. Examination of the nose and throat, including a roentgenogram of the sinuses, showed nothing abnormal. Treatment was begun on January 22, and the ear was dry by February 11; the pars tensa was destroyed.

CASE 4.—There was a history of bilateral chronic suppurative otitis media of twenty-five years' duration. After two thirds of the pars tensa of the right ear was destroyed the inner wall was granulating, and there was an offensive discharge. The patient was admitted to the hospital for radical mastoidectomy on the right. He was seen as an outpatient two months later (June 1946), with an

apparently completely epithelized right mastoid but with minimal discharge from the region of the eustachian tube; the left ear was unchanged. Both ears were treated with penicillin (5,000 units per cubic centimeter), 20 per cent sulfathiazole in saline solution, alcohol and boric acid drops, without favorable results. On May 21, 1947 both ears were as they have been described in June 1946. On May 29 Proteus morganii was isolated from both ears; that from the right ear was sensitive to streptomycin in a strength of 20 units per cubic centimeter and that from the left ear in a strength of 500 units. Streptomycin treatment was begun on June 4. By July 2 both ears were dry, but there was a large perforation of the left tympanic membrane with a healthy inner wall. Bacteriologic study at that time showed a light growth of a nonpathogenic corynebacteria from both ears. Audiograms made on July 4 showed a measured loss for speech thresholds of 30 decibels in the right ear and of 10 decibels in the left ear; the loss in September 1946 had been 56 decibels in the right ear and 24 decibels in the left ear. Use of a hearing aid or of lip reading was unnecessary.

CASE 5.—There had been an intermittent discharge from the right ear for four years, with frequent discomfort and pain over the right mastoid region. Examination of the nose and throat and of the left ear revealed an essentially normal condition. There was chronic suppurative otitis media on the right with a perforation of the posterior inferior quadrant of the tympanic membrane. Bacteriologic study on November 24 revealed a light growth of Escherichia coli sensitive to streptomycin in a strength of 100 units per cubic centimeter. Treatment was begun, but the discharge from the right ear was persistent. On December 22 there was a moderate growth of Staphylococcus pyogenes aureus resistant to penicillin in a strength of 10 units per cubic centimeter (streptomycin sensitivity is usually not investigated when invaders are known to be gram-positive). Streptomycin therapy was continued until January 20, when bacteriologic study again showed Staph. pyogenes sensitive to penicillin in a strength of ½ unit per cubic centimeter. Penicillin therapy was then instituted. The right ear became dry and intact, with normal details of the tympanic membrane again visible. In this case it is presumed that streptomycin eliminated E. coli, because of the chronicity, and that penicillin eliminated the secondary invaders.

CASE 6.—There was a two year history of chronic suppurative otitis media on the left following explosive trauma. Bacteriologic study showed Pseudomonas sensitive to streptomycin in a strength of 35 units per cubic centimeter. The discharge ceased after seven days of treatment. Examination two weeks later showed a dry ear, with a large perforation of the anterior inferior quadrant, and bacteriologic study on March 17 showed no growth after four days of incubation. Examination about eight months later showed a large perforation of the anterior inferior quadrant of the left tympanic membrane, and bacteriologic study revealed a light growth of Staph. aureus presumably a contaminant.

CASE 7.—There was a history of chronic suppurative otitis media on the left with perforations of the attic and of the posterior inferior quadrant. At the initial examination "chronic pharyngitis" was recorded. Bacteriologic study in October 1947 showed a moderate growth of A. aerogenes sensitive to streptomycin (20 units per cubic centimeter) and a moderate growth of a second strain, also sensitive to the antibiotic (10 units per cubic centimeter). One week of streptomycin therapy produced a decided decrease in the discharge. At this time, because of discomfort in the throat, the sinuses were investigated; roentgenograms showed definite opacity of the right antrum and a less pronounced opacity of the right frontal sinus and the right ethmoid labyrinth. A diagnosis of hyperplastic sinusitis was made. One week later, three weeks after the start of treatment, the

left ear was dry, with a perforation of the posterior inferior quadrant. Bacteriologic study showed no growth after four days of incubation. Since subjective symptoms of sinusitis were not severe, no attempt was made to treat this condition. It is felt, however, that if suppuration from the middle ear should recur in this case appropriate surgical treatment of the sinus condition should be carried out—probably a radical antrotomy on the right and an anterior ethmoidectomy. The patient was referred for audiograms.

CASE 8.—The patient was first seen on October 14 with chronic suppurative otitis media on the right, with a large central perforation of the tympanic membrane, and a history of direct trauma six years previously. Bacteriologic study two weeks later revealed a light growth of Staph. pyogenes sensitive to streptomycin in a strength of 10 units per cubic centimeter and to penicillin in the same strength. Streptomycin therapy was begun. The right ear was dry three weeks later, but the pars tensa was destroyed. On November 21 bacteriologic study showed a moderate growth of micrococci. In this case, as in all others, penicillin (5,000 units per cubic centimeter) had been administered while the results of sensitivity tests were being awaited. The causative organism was later shown to be sensitive to both streptomycin and penicillin; but, since the patient used the latter for two weeks without appreciable effect, the beneficial results in this case must be attributed to streptomycin.

CASE 9.—There was a history of chronic suppurative otitis media (left ear) for six years. Radical mastoidectomy had been done in 1941, with a revision in 1946. There was a profuse purulent discharge with granulations of the attic. On March 17 P. intermedius, sensitive to streptomycin in a strength of 30 units per cubic centimeter, and Pseudomonas, sensitive to streptomycin in a strength of 50 units, were isolated. On April 30 a polyp or large granulation was removed with a snare. Bacteriologic study on May 19 revealed a heavy growth of P. intermedius, obscuring gram-positive cocci. Streptomycin therapy was not begun until June 11. On July 14 the left ear was dry and completely epithelized. In view of the apparently dry ear, it is of interest that on July 28 bacteriologic study showed a heavy growth of P. intermedius sensitive to streptomycin in a strength of 100 units per cubic centimeter and a heavy growth of Achromobacter resistant to 500 units of streptomycin per cubic centimeter. When the patient was seen on September 22, there was a profuse discharge of pus from the left ear. Bacteriologic study at that time showed a moderate growth of P. intermedius, a light growth of Pseudomonas, micrococci and nonpathogenic organisms (sensitivity tests not made). In view of the persistence of the discharge from the left ear, the sinuses were carfeully studied, and the moderate opacity of both antrums shown on the roentgenograms was regarded as of special interest, but finally as of little significance. Bacteriologic study on October 24 showed P. intermedius sensitive to 50 units of streptomycin per cubic centimeter and Pseudomonas sensitive to 1 unit of the drug per cubic centimeter. Streptomycin therapy was again begun on November 3, and three weeks later the left ear was completely dry and the site of the radical mastoidectomy was completely epithelized. Audiograms showed a normal right ear. In the left ear there was a calculated hearing loss for speech of 36.8 per cent and a measured hearing loss for speech (speech-effective threshold) of 40 decibels.

CASE 10.—There was a five year history of chronic suppurative otitis media on the left, with a perforation of the anterior inferior quadrant of the tympanic membrane. Bacteriologic studies on October 6 showed a heavy growth of organisms of the Achromobacter group, sensitive to 100 units of streptomycin per

cubic centimeter. Treatment was begun, and on October 23 there was a minimal serous discharge from the left ear; in other respects that ear was improved. Therapy was continued. On October 27 bacteriologic study showed a light growth of micrococci and Bacillus subtilis. On December 17, the left ear was dry, and the tympanic membrane was intact, freely movable and moderately retracted. Bacteriologic study then showed a very light growth of a hemolytic Staph. pyogenes.

CASE 11.—There was a history of chronic suppurative otitis media on the left, with intermittent discharge for three years. The patient stated that streptomycin had been used topically while he was hospitalized for osteoarthritis in March 1947. The pars tensa of the left tympanic membrane was destroyed and the ear was dry when he was seen on July 10, 1947. On September 16 he was seen with a purulent discharge from the middle ear and visible pulsation—apparently an acute exacerbation of the chronic suppurative otitis media—on the left. Bacteriologic study on September 25 revealed a heavy growth of Proteus sensitive to streptomycin in a strength of 20 units per cubic centimeter and a heavy growth of organisms of the Achromobacter group sensitive to streptomycin in the same strength. Therapy was begun on September 30, and there had been no change in the patient's condition by October 14. Bacteriologic study on October 21 showed a growth of P. intermedius sensitive to 100 units of streptomycin per cubic centimeter. On December 29 the left ear was dry, and audiograms showed a calculated loss of hearing for speech of 14 per cent in the left ear and a measured loss of 12 decibels.

CASE 12.—There had been no history of discharge from the left ear until about June 1, 1947. Examination on July 9 showed a large perforation of the posterior inferior quadrant of the left tympanic membrane, with a seropurulent discharge and visible pulsation. The condition was regarded as subacute suppurative otitis media and was treated with 1 ounce (30 cc.) of 70 per cent alcohol and 16 grains (1.04 Gm.) of boric acid powder. On July 23 there had been no change. Stereoscopic roentgenograms of the mastoids showed cloudiness of the cellular structures on the left side. Since bacteriologic study on July 20 showed only nonpathogenic organisms, sensitivity tests were not made. On August 6 there had been no essential change, either objectively or subjectively, from home use of penicillin (5,000 units per cubic centimeter). Bacteriologic study on August 11 revealed Achromobacter sensitive to 10 units of streptomycin per cubic centimeter and A. aerogenes sensitive to 100 units per cubic centimeter. The condition of the left ear was regarded as potential acute mastoiditis. Therapy was begun on August 13, and two weeks later the left ear was much improved, with less pus, absence of visible pulsation and no discomfort. Roentgenograms on September 10 showed the cellular elements of the left mastoid to be more clearly defined than on July 23. Streptomycin therapy was continued. Bacteriologic study on August 30 showed only nonpathogenic organisms. When the patient was seen on September 22, the left ear was dry and there was a large central perforation, although bacteriologic study two days previously had shown a resistant, aerobacter-like organism sensitive to 500 units of streptomycin per cubic centimeter. This is the only case of the group which may perhaps be regarded as being of doubtful chronicity, inasmuch as the patient came under observation about six weeks after the onset of the otitis media.

CASE 13.—The patient had had bilateral chronic suppurative otitis media of thirty years' duration, with a thick purulent secretion and destruction of the pars tensa of both ears. Bacteriologic study of both ears on July 26 showed a heavy

growth of Staph. pyogenes sensitive to 20 units of streptomycin and 5 units of penicillin per cubic centimeter. Penicillin therapy was continued. Bacteriologic study on August 11 showed a light growth of Pseudomonas sensitive to 100 units of streptomycin per cubic centimeter. Streptomycin therapy was instituted on August 18. On September 2 the right ear was dry and the pars tensa destroyed. Through a misunderstanding, the left ear was not treated at home and showed the suppurative otitis, as it had previously. Treatment of the left ear was begun on September 2. On September 22 both ears were dry and the pars tensa of each ear was destroyed. The inner walls were healthy. Bacteriologic study of both ears on September 25 showed a moderate growth of micrococci and yeastlike organisms on direct smears; these organisms failed to grow after seven days of incubation. Audiometric study on October 29 showed a severe bilateral hearing defect of mixed type. The calculated loss of hearing for speech by pure tone audiometry was 60 per cent on the right and 59 per cent on the left; there was a measured loss of hearing for speech of 70 decibels on the right and of 76 decibels on the left. In this case it is also interesting to note the unaided elimination of Staph. pyogenes by penicillin and the subsequent appearance of Pseudomonas, which was eliminated by streptomycin.

Case 14.—The patient had had chronic suppurative otitis media for two years, with a discharge of pus from a perforation in the anterior inferior quadrant of the right tympanic membrane. Bacteriologic study on Feb. 7, 1948 showed a growth of Pseudomonas sensitive to streptomycin in a strength of 500 units per cubic centimeter, and therapy was begun February 16. On March 1 there was no evidence of discharge from the right ear, but there was a large perforation of the anterior inferior quadrant of the tympanic membrane. The discharge ceased one week after treatment was begun. Bacteriologic examination on March 8 showed a light growth of micrococci. The patient was referred for audiograms.

Case 15.—The patient had had defective hearing in both ears and a discharge from the left ear since 1915. The right tympanic membrane was retracted; there was no suppuration and no evident scars, but the pars tensa of the right tympanic membrane had apparently been replaced by a false membrane. The pars tensa of the left ear was destroyed, but the inner wall was healthy and there was no evidence of suppuration. The patient was advised to return when there was an evident discharge from the ear, which occurred five days later. Bacteriologic study of the purulent discharge from the left middle ear on February 9 showed a heavy growth of Achromobacter sensitive to 100 units of streptomycin per cubic centimeter. Therapy was begun on that date, and one week later the left ear was dry. Bacteriologic examination on February 20 showed no growth after four days of incubation. The patient was referred for audiograms.

In addition to the group of 15 cases already reviewed, in all of which the response to streptomycin therapy was favorable, there remain for consideration, as of March 2, 1948, 5 other cases in which the condition has not responded to treatment thus far, in any form, including use of streptomycin. Five others came under observation too recently to permit all necessary investigations being carried out, in particular the elimination of pathologic conditions of the nose and throat and compilation of bacteriologic data, in sufficient time for their inclusion in this report.

The case records of the 5 cases of therapeutic failure show the following points of interest. One case was complicated throughout with intractable diffuse external otitis, with recurring furunculosis; and, while at first there were a growth of Escherichia coli sensitive to streptomycin in a strength of 10 units per cubic centimeter and a heavy growth of Achromobacter sensitive to the drug in a strength of 100 units per cubic centimeter, a strain of Achromobacter resistant to streptomycin in a strength of 500 units per cubic centimeter later developed. Roentgenograms showed definite and rather extensive sclerotic changes of the mastoid, and there was evidence of moderate thickening of the mucous membrane of both antrums. The patient will be called in for review. In another case (O. C.) there was a profuse discharge of an offensive secretion through a perforation in the posterior inferior quadrant at the time treatment was commenced, and bacteriologic tests showed Pseudomonas sensitive to streptomycin in a strength of 500 units per cubic centimeter. After streptomycin therapy, culture yielded both gram-negative and gram-positive micrococci and a yeastlike organism, and the suppurative otitis media persisted. In this case, as in the first case, roentgenographic examination indicated involvement of the accessory sinuses (moderate opacity of the right antrum), and the case will be reviewed. In a third case (R. S.), in which the right ear had been involved since childhood, streptomycin treatment was instituted on Oct. 15, 1947. Bacteriologic report on September 29 showed P. vulgaris sensitive to streptomycin in a strength of 20 units per cubic centimeter. At that time the condition was one of chronic suppurative otitis media of the right ear with perforation of the attic. Roentgenologic examination of the right mastoid on June 19, 1947, had shown a possible cholesteatoma, with the cells of the right mastoid replaced by a dense opacity. Bacteriologic examination on November 5 revealed a hemolytic streptococcus, which failed to grow on subculture in sensitivity tests. At that time roentgenologic examination of the accessory sinuses of the nose, previously overlooked, showed dense opacity of the left antrum and, to some extent, of the right antrum, and further inquiry indicated that the patient had been subject to acute head colds and postnasal discharge for three years. Bilateral radical antrotomy was recommended; but, as further investigation with iodized oil U. S. P. after admission to the hospital indicated no filling defect of the right antrum, a radical antrotomy was done only on the left side, about November 15. Bacteriologic study on December 16 showed a heavy growth of Staph. pyogenes sensitive to penicillin in a strength of 0.05 unit per cubic centimeter and to streptomycin in a strength of 30 units per cubic centimeter. Therapy with streptomycin was again applied. Bacteriologic examination on January 12 showed a heavy growth of Staph. pyogenes sensitive to 0.1 unit of penicillin, as well

as a heavy growth of a corynebacterium. A small amount of purulent secretion continued from the right middle ear, and the patient will be recalled in three months for review, with special reference to the possibility of an existing cholesteatomatous process and associated pathologic condition of the right antrum. Streptomycin therapy in a fourth case (A. W.) was commenced on Nov. 5, 1947, because of chronic suppurative otitis media of the left ear of five years' duration. Bacteriologic study on October 27 showed a heavy growth of P. intermedius sensitive to 50 units of streptomycin per cubic centimeter. After treatment, bacteriologic study, on November 23, showed no change (P. intermedius sensitive to 50 units of streptomycin). At that time the left ear showed no change, and on examination on December 10 there remained a persistent purulent discharge from the left ear through a perforation in the posterior inferior quadrant. No evidence of a pathologic condition of the sinus was found, and the fact that no change in the bacteriologic status occurred after streptomycin therapy, although sensitivity had been shown, was disappointing. This case will be reviewed in three months. Records of the fifth case (A. B.) showed bilateral chronic suppurative otitis media of three years' duration following an explosive blast. Bacteriologic study on January 15 showed P. intermedius in both ears, the organisms in the right ear showing sensitivity to streptomycin in a strength of 500 units per cubic centimeter, and those in the left ear being resistant to the same concentration. Both ears were treated with streptomycin, and on February 2 the left ear was dry and has remained so, despite the resistant strain shown in the culture of January 15. Bacteriologic examination on February 23 showed a heavy growth of Achromobacter resistant to streptomycin in a strength of 500 units per cubic centimeter in the right ear, and the left ear showed no growth after four days' incubation. The right ear continued to show evidence of chronic suppurative otitis media without change, and the patient will remain under observation. It will be noted that in 3 of the 5 cases of therapeutic failure there is presumptive evidence of a pathologic condition involving the accessory sinuses of the nose and that in 1 of these a cholesteatomatous process is suspected.

SUMMARY

Available literature records little to date on the treatment of chronic suppurative otitis media with the topical application of streptomycin. This form of treatment is discussed, and the cases of 20 outpatients of the Queen Mary Veterans' Hospital, Montreal, are reviewed, as being of possible interest.

The requisites in each case of this group for the institution of streptomycin therapy were as follows: (*a*) the existence of chronic sup-

purative otitis media, with well established chronicity; (*b*) sensitivity of the invading organisms to streptomycin, and (*c*) the topical application of penicillin (5,000 units per cubic centimeter) twice daily, for two weeks as directed, for the elimination of as many gram-positive organisms as possible.

In cases in which the response to the established routine and treatment was favorable, the offending organisms found in pure culture, showing sensitivity to streptomycin, were of the following bacteriologic groups, mentioned in the order of their frequency: Achromobacter, Pseudomonas, Proteus intermedius and Proteus morgani, Aerobacter aerogenes, Escherichia coli and Staphylococcus pyogenes.

Of the group of 20 patients whose treatment was completed, 15 were shown to have responded favorably, as evidenced by "dry ears" and absence of pathogenic bacteria in the majority of cases, and 5 were regarded as therapeutic failures, 3 of whom gave evidence of some other pathologic condition, probably closely associated with suppuration of the middle ear and involvement of the mastoid.

Duration of treatment varied from one to twelve weeks. In 8 of the 15 cases with successful outcome it did not exceed three weeks; but, for obvious reasons, the estimation of the time factor in connection with outpatients was not found practical.

The evidence made available in this report indicates that the topical application of streptomycin has a definite place in the treatment of chronic suppurative otitis media, in fact, that it may well be the treatment of choice in many cases in which formerly there has been no response to treatment. There are apparently no contraindications to the topical use of the drug. Local reactions did not occur, and, as is well known, streptomycin is particularly effective in combating invasion of the majority of gram-negative and some gram-positive organisms.

1463 Bishop Street.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

THE PARANASAL SINUSES

SAMUEL SALINGER, M.D.
CHICAGO

ANATOMY, PHYSIOLOGY, PATHOLOGY AND DIAGNOSIS

Anatomy.—Canaveris [1] made a study of the sinuses in the dog, cat, rabbit, guinea pig and hog as a basis for comparison with the human anatomy. Points of similarity and differences are noted with the help of several fairly good photographs of cross sections of the head. The details are too numerous to permit an adequate abstract in a limited space. In the dog one finds a frontal, a maxillary and a small sphenoid sinus. The cat has a large frontal and sphenoid sinus and a rather small antrum. In the guinea pig all the sinuses are more or less rudimentary. The same applies to the rabbit. In the hog one finds the sinuses more definitely developed. If one is interested in comparative anatomy, it would be well worth while to read the article in its entirety.

Physiology.—In an extensive monograph replete with technical details, summaries of experiments and discussions of results, Moe [2] attempts to answer the question of the effect of nasal operations on the functional capacity of the nasal organ. He is concerned particularly with the results of the so-called lumen-dilating operations, such as submucous resection of the septum and partial or complete reduction of the turbinals. By means of complicated apparatus the author was able to measure and record the variations in the temperature of air at inspiration and expiration, the absolute humidity and the dust-filtering capacity of the nose under varying conditions. Readings were taken in a number of normal persons and in a group of patients previously operated on at room temperatures as well as in the lower temperature outdoors. It was found that the nose possesses a great capacity for accommodating itself to varying conditions; for instance, the readings for the total nose varied but little from those recorded when only one half of the nose was functioning. Also, it was shown that the removal of even a considerable amount of turbinal tissue failed to reduce the heating and moistening function. One third of the inferior turbinate

1. Canaveris, R. G.: Los senos paranasales en algunos mamiferos, Rev. brasil. de oto-rino-laring. **15**:57 (March-April) 1947.

2. Moe, R.: The Effect on the Respiratory Functions of the Nose of the Lumen-Dilating Nasal Operations, Acta oto-laryng., 1941, supp. 45, p. 1.

can be removed without affecting the readings. Much evidence is introduced to show that postoperative dryness is not due entirely to the expansion of the air spaces in the nose or the removal of mucous membrane but rather to a pathologic process already present in the nasal mucosa. Absence of dryness and crusting in several cases in which extensive intranasal surgical procedures were performed is cited as corroborating this observation.

The author's observations are detailed and instructive, and the data which he accumulated are as accurate as the most modern apparatus can make them. They may be accepted as authoritative and should be useful for reference, for treatment and as a basis for future investigation. Among these are the following:

The nasopharyngeal temperature at room temperature (+ 19 C.) averages 30.98 C. at inspiration and 33.92 C. at the finish of expiration. When taken outdoors at 6.3 C. the corresponding readings are 29.54 and 33.6 C. This shows how well the nasal organism accommodates itself to a fall in temperature. The humidity in the nasopharynx at room temperature averages 15 mg. per inspiration at room temperature and 14 mg. at an outdoor temperature of + 4.38 C. The dust-filtering efficiency of the normal nose averages about 37.82 per cent. The readings in persons previously operated on are slightly lower than normal and show a greater sensitivity to lowered temperatures. Surprisingly, however, the dust-filtering efficiency was found to be higher than normal in the persons operated on.

As stated previously, the persons operated on failed to show any of the "major clinical consequences of functional disturbance, such as dry atrophy of the mucosa."

Robison [3] elaborates further on his theories concerning the lymph drainage from the sinuses (abstracted in this review in September-October 1945). He contends that lymph drainage from the sinus mucosa is delayed because of the rigidity of the walls of the cavity which deprives the tissues of transmitted pressure from vessels in surrounding tissues, which in other locations facilitates absorption and elimination of accumulated fluids. Prolonged retention of fluid in the tissues, such as occurs in allergic states, predisposes to secondary infection, with ensuing fibrotic changes leading to a chronic infected state. The author reasons, therefore, that the application of pressure to the edematous mucosa should facilitate the expulsion of the fluid. To this end he applies hydrostatic pressure through rubber balloons inserted into the antrums by way of the inferior meatus. A number of roentgenograms showing these balloons in situ are presented, as well as typical case histories.

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3. Robison, J. M.: Pressure Treatment of Allergic Sinusitis, Arch. Otolaryng. **45**:405 (April) 1947.

Pathology.—Fenton and Larsell [4] studied the effects of penicillin on experimentally induced virulent sinusitis in cats. Six cats were infected by the instillation of a culture of Streptococcus pyogenes into the frontal-sinuses, which were then treated with penicillin solutions. Subsequently the animals were destroyed and the tissues removed for study. The solution employed averaged 2,000 units per cubic centimeter. It was found that in the treated animals the surface bacteria were rapidly destroyed and fewer bacteria were found in the goblet cells and deeper tissues than in the control animals. However, it was noted that the "acute inflammatory reaction persisted longer after local treatment with penicillin than in earlier experiments, in which no such treatment was used. This suggests that the active stage of phagocytosis by polymorphonuclears is of longer duration and is, therefore, in all probability more effective." In human subjects the authors found a concentration of 1,000 units per cubic centimeter less irritating, and they believe that phagocytosis is accelerated through its action.

Diagnosis.—Dysart [5] recommends measuring the amount of fluid the maxillary sinus will hold before overflowing as one method of determing its size and the state of its lining membrane. The average normal antrum holds about 15 cc. in men and 12 cc. in women. If the sinus overflows at a considerably lesser amount, it might indicate the presence of accumulated secretions, polyp, tumor or thickened membrane. Also, a capacity that varies widely at different times might suggest an allergic state. The author also has found this simple procedure of value in connection with the capacity of the sphenoid sinuses. When the capacity of the antrum is being measured the head is held forward. When the sphenoid sinus is being measured, the head is tilted backward and the patient indicates the moment when he first begins to feel the solution coming into the throat.

Cohn [6] reviews the symptomatology and diagnosis of all types of sinusitis and stresses maxillary sinusitis without apparent discharge and neuralgias which he believes are due to chronic infection of the ethmoid and sphenoid sinuses. The usual diagnostic procedures are gone over, and attention is directed to errors in interpretation of roentgenograms of the frontal sinus in cases in which blurring may be due to obstruction of the duct. The author reports good results from the use of antibiotics in acute cases but finds them of little value when employed locally. He believes that administration of sulfonamide drugs

4. Fenton, R. A., and Larsell, O.: Tissue Changes in Sinus Membranes After Penicillin Treatment, Ann. Otol., Rhin. & Laryng. **56**:245 (June) 1947.

5. Dysart, B. R.: Measurement of the Overflow Capacity of the Maxillary Sinus and Its Significance, Arch. Otolaryng. **45**:173 (Feb.) 1947.

6. Cohn B., M.: Diagnóstico y tratamiento de las sinusitis, Rev. otorrinolaring. **6**:149 (Dec.) 1946.

lowers body defenses and recommends using proteins in conjunction. He prefers the Caldwell-Luc operation for the maxillary sinus, endonasal procedures for the ethmoid sinus and the Riedel technic for the frontal sinus. Also he recommends the de Lima operation in cases of pansinusitis and Segura's transseptal procedure for use in cases of sphenoid sinusitis.

Ballantyne,[7] analyzing 75 successive cases of maxillary sinusitis, reports on the reliability of the roentgenologic findings. A comparison between these and the results of diagnostic puncture reveals the following: In 9 cases in which roentgenograms were normal but symptoms suggested the possibility of an infection, the diagnostic lavage revealed nothing abnormal. In the remaining 66 cases, in which roentgenograms revealed infection, the diagnosis was confirmed by lavage in 58 (88 per cent). Among the 8 cases in which the irrigated fluid returned clear, in 3 a diagnosis of polyp was made and in 1 a cyst was punctured. Thus in only 5 cases was a pathologic process not demonstrated despite positive roentgenologic findings. (Is it not possible that these cases may have been caused by transient edema of allergic origin?—S. S.)

Proetz[8] offers a number of critical suggestions with reference to the interpretation of roentgenograms of the sinuses. He finds fluid levels less frequently demonstrable than the conditions which produce them. This may be due to viscosity or to a tendency for the fluid to adhere to the walls. A fluid level arising from an infected dental root is a valuable diagnostic sign.

Roentgenograms of the sinuses after the subsidence of acute symptoms are often of great value in demonstrating residual thickening of the mucosa. The author favors the use of a contrast medium for the delineation of mucosal thickness and contours. Also, considerable knowledge may be gleaned by observing the emptying time, which normally should be about seventy-two hours. Marked delay of emptying is certainly significant, since it indicates a slowing of ciliary activity.

Aboueker and others[9] comment on the finding of a fluid level in roentgenograms of the sinus and cite 2 cases in which it aided in diagnosis. One was that of a 60 year old woman in whom, after a grippal attack, a severe orbital reaction with fever, pain, nasal blockage, exophthalmos, chemosis, corneal insensitivity, periorbital edema and reduced vision developed rapidly. The nasal examination revealed

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7. Ballantyne, J. C.: On the Relationship Between Radiological Appearances and Proof-Puncture Findings in Suspected Cases of Infection of the Maxillary Antrum, J. Laryng. & Otol. **61**:306 (June) 1946.

8. Proetz, A. W.: Evaluation of X-Ray Evidences of Sinus Disease, Canad. M. A. J. **56**:183 (Feb.) 1947.

9. Aboueker, P.; Djian, and Cremer: Images radiologiques des niveaux liquides dans certaines formes de sinusitis, Ann. d'oto-laryng. **54**:308 (May-June) 1947.

nothing abnormal, but roentgenograms showed a definite fluid level in the antrum, while the ethmoid and sphenoid sinuses were clear. The antrum was opened, releasing some pus, but the ethmoid and sphenoid sinuses revealed only a collateral edema.

In the second case a child of 8 presented signs of an orbital abscess. Roentgenograms showed a fluid level, which was confirmed at operation.

Larroude [10] subdivides chronic sinusitis into serous, catarrhal and purulent and gives a brief summary of the pathologic aspects of each. He also describes a form of sinusitis without exudate in which the symptoms are minimal or nonexistent. However, the patient presents general symptoms of a focal infection, and the histologic examination of the sinus reveals thickened reddened mucosa, at times covered with fungoid excresences. The vessels are dilated, as are the ducts of the mucous glands; there is a general infiltration with cells, mostly lymphocytes and plasma cells. In differentiating these types from the purely allergic reactions, he finds the use of contrast mediums of value. At times the edema about the ostium may be so great as to interfere with the introduction of the fluid. When admitted, it will show a uniform swelling of the lining and a normal emptying time, which is significant. Also, when repeated examinations are made, it will be noted that the mucosa undergoes rapid changes in its thickness, which is not the case in the purely infectious conditions. Also the cytologic examination of secretions is of value in the differentiation. The greatest difficulty arises in the cases in which infection is superimposed on an allergic status or vice versa. Several cases are cited.

Roentgenologic investigation [11] using contrast filling of the maxillary sinus serves as a principal or auxiliary method. In inflammatory conditions of the mucous membrane of the sinus this method shows the condition of the mucosa and indicates the need for chemotherapy or operation. From the shape of the contrast picture of the filling, the inflammatory changes of the mucous membrane or new growths in the sinus can be ascertained. In these cases the method may be used as the principal method of investigation.

"In malignant growths and in inflammatory conditions of the bone tissue this method is an auxiliary procedure of investigation and is very important in cases calling for operation."

Baylin and Kerman [12] made a study of the sphenoidal fissure from the roentgenographic point of view, pointing out the various normal

10. Larroude, C.: Sinusites chroniques et allergie, Rev. de laryng. **69**:38 (Jan.) 1948.

11. Polednak, L.: Roentgenologic Diagnosis by Means of Contrast Filling in Diseases of Maxillary Sinus, Lék. listy **2**:315, 1947.

12. Baylin, G. B., and Kerman, H. D.: The Roentgen Examination of the Sphenoidal Fissures, South. M. J. **40**:281 (April) 1947.

configurations and the alterations observed as a result of disease or new growth. These apertures are easy to delineate in the usual frontal exposure. Destruction of the outlines due to disease, fracture lines, hyperostoses and exostoses are readily demonstrated. From the point of view of the orbit and the sinuses, a careful study of this anatomic structure may prove valuable, as demonstrated in a number of roentgenograms presented by the authors. One case of an osteoma is described, with a discussion of the differential diagnosis.

Viviani [13] discusses the value of roentgenograms in the diagnosis of various conditions in the sinuses and shows several drawings indicating the projections required to differentiate fluid levels and tumors.

Di Lauro [14] discusses the relative value of roentgen study, transillumination and diagnostic puncture in the diagnosis of maxillary sinusitis, particularly the nonsuppurative type and claims on the basis of his personal experience that puncture lavage through the inferior meatus is the most reliable. He speaks of the procedure in connection with medicolegal matters but fails to make the point clear, although he does discuss the importance of an analysis of the sinus secretion in connection with the determination of a focal infection.

Frouchtman and Ferrando [15] have found that the injection of 0.5 to 1 cc. of a 1 to 1,000 dilution of epinephrine into the antrum is a valuable diagnostic procedure in differentiating a purely allergic edematous swelling of the lining from that due to an infectious process. Suspicious clouding clears up within a few minutes, as proved by transillumination and roentgen ray.

INTRACRANIAL COMPLICATIONS

Of a group of 37 cases of meningitis, Smith and his associates [16] list 9 as due to sinusitis and 7 as due to complicating fracture into the sinuses. Cerebral abscess was frequently seen in association and at times was difficult to diagnose because of the predominant meningeal symptoms. The incidence of cerebral abscess was much lower in cases in which pneumococci were the offending agents than in cases of streptococcic infection. They believe that most of these were due

13. Viviani, C.: Exploración radiológica en la sinusitis, Rev. otorrinolaring. **7**:193 (Dec.) 1947.

14. di Lauro, E.: La puntura del seno mascellare per via intrameatica: Sua importanza diagnostica, medico-legale e terapeutica, Med. internaz. **55**:180 (July-Aug.) 1947.

15. Frouchtman, R., and Ferrando, J. M.: Una prueba diagnóstica de las sinopatías maxilares reaccionales, Rev. clín. españ. **22**:219 (Aug. 15) 1946.

16. Smith, H. V.; Schiller, S., and Cairns, H.: Discussion on the Chemotherapy of Meningitis Secondary to Infection of the Ear and Sinuses, J. Laryng. & Otol. **61**:313 (June) 1946.

to anaerobes. The patients with meningitis were given penicillin intrathecally and systemically, with sulfadiazine by mouth. Intrathecal injections of 8 to 10,000 units (2,000 units per cubic centimeter) were given at twelve hour intervals during the first two days and then daily. The results of the therapy were checked by daily bacteriologic count. Sulfadiazine was given by mouth in doses of 12 Gm. every twenty-four hours; also penicillin was given by continuous intramuscular drip or at three hour intervals.

When an abscess is suspected it should be searched for and, if found, evacuated. This is followed by instillation of penicillin (10,000 units per cubic centimeter). Subdural abscess is treated by irrigation with penicillin solution through indwelling smaller catheters inserted through several burr holes. Intraventricular injections of penicillin may also be employed.

The primary focus in all cases should be adequately drained.

Anderson [17] reports 3 cases of subdural empyema secondary to frontal sinusitis, with the results of autopsy in 2. The third patient recovered. He attributes the successful result in this case to early operation and points out the irreparable damage sustained by the brain as a result of delay.

Symptoms of headache, stiff neck, somnolence, jacksonian seizures and hemiparesis are the most characteristic. Early drainage is accomplished through enlarged burr holes in the frontal, parietal and temporal regions, providing through and through drainage.

Mitchell [18] reports 7 cases of meningitis, of which 2 were due to disease of the frontal sinus. In both patients the sinus was drained by way of a small trephine opening in the floor, without any further surgical procedure. Both recovered under supportive antibiotic therapy.

A case of brain abscess was encountered which developed nineteen days after an operation on the external sinus. The abscess, which was superficial, was widely opened and packed. However, the patient succumbed, and autopsy revealed a large superficial abscess in the parieto-occipital region. The failure in this case was therefore one of incomplete diagnosis.

Garcés [19] finds endocranial complications of sinusitis to be uncommon in Chile. He is convinced that in most cases the infection is transmitted by way of the veins; yet he has never seen a case of thrombosis of the sagittal or cavernous sinus due to a sinus infection.

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17. Anderson, F. M.: Subdural Empyema Secondary to Frontal Sinusitis, Ann. Otol., Rhin. & Laryng. **56**:5 (March) 1947.

18. Mitchell, G.: Clinical Experiences with Intracranial Complications of Ear and Sinus Disease, Texas State J. Med. **43**:25 (May) 1947.

19. Garcés, J.: Complicaciones endocraneanas de las sinusitis, Rev. otorrinolaring. **6**:213 (Dec.) 1946.

Subdural abscess is difficult to differentiate from cerebral abscess and frequently is not diagnosed until operation. He reports 1 case in which the condition was due to chronic sinusitis, which he claims is unusual, since in most reported cases it has been due to acute or subacute sinusitis. Also, he reports 2 cases of abscess of the frontal lobe and comments on the surgical procedure indicated. He finds the sulfonamide drugs more effective in these cases than penicillin, which he states has difficulty in penetrating the fibrous barrier about the abscess.

Mayoux and Martin's case [20] involved a man who underwent a Caldwell-Luc operation for a chronic infection of the maxillary sinus of dental origin. Persistence of the discharge led to a second procedure, in which the ethmoid sinuses were cleaned out. Two months later the patient returned because of severe headaches, and since roentgenograms revealed a cloudy frontal sinus, he was again operated on. The frontal sinus was found full of pus and fungoid degeneration of the mucosa. Headaches persisted, becoming more severe and accompanied with an elevation of temperature and convulsive seizures. Spinal tap revealed 43 cells per cubic centimeter, and the fluid was free of bacteria. Sulfonamide compounds helped for a while, but the symptoms then became more severe and there were signs of intracranial pressure, which led to a decision to explore. Resection of the supraorbital bone disclosed the dura covered with granulations and a perforation through which a foul pus exuded, which on culture yielded streptococci. To avoid draining through the orbit the brain was exposed through the frontal bone. A trocar encountered resistance of a capsule. It was therefore decided to rely on aspiration and sulfonamide compounds. Unfortunately the primary improvement was short lived. The patient suffered an acute blockage and died. Autopsy revealed two small abscesses in the temporal lobe about the size of a walnut. There was no sign of capsule formation, and the location of the abscesses was such as to have made drainage by puncture alone ineffective. The authors comment on the phenomenon of multiple abscesses developing over a period of several months without encapsulation, which is contrary to the generally accepted notion.

Piquet [21] reports a case of frontal lobe abscess in a man of 26 that terminated fatally, despite drainage and large doses of penicillin. The condition followed frontal sinusitis, which developed ten days after an acute infection of the upper respiratory tract. Severe menin-

20. Mayoux and Martin: Abcès du lobe frontal non enkysté après plusieurs mais d'évolution, Ann. d'oto-laryng. **64**:304 (May-June) 1947.

21. Piquet: Abcès cérébral double par sinusite frontale: Traité par drainage, puis par ablation neurochirurgicale: Mort, Ann. d'oto-laryng. **64**:305 (May and June) 1947.

geal symptoms led to an operation on the frontal sinus. Both sinuses were badly diseased; the intersinus partition was destroyed with sequestration of the posterior wall, behind which was a large extradural abscess. Despite chemotherapy the symptoms persisted, and a second operation disclosed more extradural pus and a frontal lobe abscess communicating with a secondary abscess farther back. Large doses of penicillin were given, but the patient succumbed. The author feels that in such cases it would be better to destroy the tissue between two abscesses so as to facilitate drainage instead of relying on iodoform gauze drain.

The following case was presented at a regular clinicopathologic meeting of the Massachusetts General Hospital.[22]

A 37 year old pregnant woman had a headache and a high temperature for two days which developed into a full-blown suppurative meningitis, the spinal fluid yielding 336,000 cells per cubic centimeter, mostly polynuclear cells. Also, type 4 pneumococci were recovered. Roentgenograms showed lobar pneumonia on the right side. Despite extensive chemotherapy and the use of antipneumococcic serum, the patient succumbed after having given birth to a child on the tenth day, which survived only a few hours. In the discussion, Dr. W. Richardson stated that the onset suggested the possibility of sinusitis and mentioned the fact that the history was not suggestive of pneumonia. He mentioned the acidosis, low carbon dioxide content and low blood sodium level as findings requiring explanation. Dr. A. M. Butler replied that the low carbon dioxide content may have been due to hyperventilation accompanying the meningitis. Also, he pointed out that the determination of the spinal fluid chloride level is useless unless tuberculous meningitis is suspected and the blood serum chloride is also measured.

Considerable discussion followed relative to the value of the roentgenograms taken at the time, the possibility of a lesion of the brain and the status of the kidneys.

Autopsy disclosed acute bacterial endocarditis, a severe chronic infection of the left ethmoid and sphenoid sinuses, some atelectasis and terminal patches of pneumonia and embolism of coronary arteries.

The conclusion reached was that the sinusitis was the primary infection and was followed by septicemia, endocarditis and septic emboli in the brain.

Among 3 cases of acute nonsuppurative encephalitis reported by Piquet [23] was 1 which was due to an infection of the frontal sinus.

22. Acute Sinusitis, Left Ethmoid and Sphenoid: Bacterial Endocarditis, Mitral Valve (Type 4 Pneumococcus); Multiple Infarcts and Abscesses of Brain, Cabot Case 33082, New England J. Med. **236**:292 (Feb. 20) 1947.

23. Piquet, J.: L'encephalite aiguë non suppurée d'origine auriculaire ou nasale, Acta oto-laryng. **35**:211, 1947.

Violent headaches and profuse nasal discharge led to exploration of the sinus. The symptoms persisted, and in a few days there were definite signs of meningitis. Administration of sulfonamide compounds reduced the temperature, but the process progressed. A contralateral hemiplegia appeared, with a positive Babinski sign and increased reflexes. Later the reflexes were lost. Symptoms all pointed to an abscess of the brain, but wide exposure, removal of the posterior wall and probing of the brain failed to disclose any pus. Nevertheless, the patient recovered.

The author believes the process to have been due to edema of the brain arising from localized meningitis. The successful outcome in this case, as well as in the 2 cases of otitic infection, was due, in his opinion, to thorough removal of the original focus plus antibiotic therapy. He believes that when exploratory puncture of the brain fails to disclose an abscess it is dangerous to extend the exploration.

Reid and McGuckin's [24] report of recovery from cavernous sinus thrombosis in 6 consecutive cases is impressive and is ample evidence of the efficacy of antibiotic therapy in this hitherto fatal complication. All the cases were due to small septic foci in the tributary areas. Some of the patients were given both sulfonamide drugs and penicillin and others sulfonamide drugs alone. The ages of the patients were 3, 16, 21, 54, 33 and 20. In 2 cases a gas bacillus was recovered. In these cases antigas serum was also administered.

The author quotes Eagleton on the six criteria necessary for establishing the diagnosis of cavernous sinus thrombosis, namely, (1) known site of infection; (2) infection of the blood stream; (3) early signs of venous obstruction; (4) involvement of nerves in the sinus; (5) neighborhood abscess of soft parts, and (6) symptoms of complicating disease.

Another case of successfully treated cavernous sinus thrombosis is reported by Muñoz MacCormick.[25] The patient was a 26 year old man in whom, during the course of a common cold, an acute frontoethmoiditis developed, with severe headache and edema of the lids appearing within forty-eight hours. This was followed by chills, nausea and vomiting, increasing edema, chemosis and paresis of the external rectus. Penicillin was given and an external frontoethmoidectomy performed. The sinuses were filled with pus and the mucosa necrotic. A rubber tube drain was inserted and penicillin instilled frequently in addition to the intramuscular injections. After a short period of improvement the symptoms increased so that the opposite orbit was involved. The use of sulfadiazine was added to the therapy, and improvement

24. Reid, J. L., and McGuckin, S.: Cavernous Sinus Thrombophlebitis: A Report on Six Consecutive Recoveries, J. Laryng. & Otol. **61**:273 (May) 1946.

25. Muñoz MacCormick, C. E.: Cavernous Sinus Thrombophlebitis Complicating Acute Fulminating Fronto-Ethmoiditis: Case with Recovery, Bol. Asoc. méd. de Puerto Rico **38**:398 (Sept.) 1946.

was noted, with gradual recession of all symptoms in the following few days. The tube drain was removed on the seventh day. Healing was completed within three weeks.

Emhart [26] reports 2 cases of thrombosis of the superior longitudinal sinus complicating frontal and maxillary sinusitis. Local nasal symptoms and roentgenograms were not helpful in the diagnosis. In 1 case a diagnosis of tuberculous meningitis was made and the true pathogenesis was not disclosed until autopsy. A boy of 18, with a history of nasal catarrh during the past five months, was suddenly stricken with symptoms of meningitis. The spinal fluid was under pressure; the albumin measured 0.8 grains (48 mg.), and there were 210 cells per cubic centimeter, mostly lymphocytes. Slight tenderness was present over the right frontal sinus, there was no pus in the nose, and the roentgenograms were normal. In addition, there was a flaccid paralysis of the right arm and leg and also the left leg. It was thought to be tuberculous meningitis, and streptomycin was given. He survived one week. Autopsy revealed thrombosis of the superior longitudinal sinus, bilateral purulent frontal sinusitis and purulent meningitis.

The second case was that of a 30 year old man who had mild sinusitis for about a month, when he suddenly went into coma. Examination revealed absence of reflexes in the lower extremities and some edema over the frontal regions, with dilatation of the veins. With the previous experience in mind, the frontal and maxillary sinuses were explored, and the right maxillary sinus was found to be infected. Penicillin was administered, and the patient recovered.

Rebattu [27] adds another case of thrombosis of the cavernous sinus successfully treated with penicillin to the growing number already recorded in the literature. It concerned a 13 year old child whose symptoms began six days previously, with pain, fever, edema and nasal discharge. On admission to the hospital, the patient already had exophthalmos, meningeal symptoms and high fever. Roentgenograms revealed pansinusitis. Lumbar puncture showed increased pressure, 600 polymorphonuclear cells per cubic centimeter, but no bacteria. The patient was given penicillin, 160,000 units every twenty-four hours. The maxillary sinus was opened and drained, and the middle turbinate was removed.

Penicillin therapy was kept up for two weeks, when the temperature reached normal. At this time there was still present a convergent strabismus, with paralysis of both the externus and the internus muscle. The pupils reacted to light and accommodation. Both fundi showed

26. Emhart, O.: Complicaciones intracraneanas osorrinógenas, Rev. otorrinolaring. **7**:138 (Dec.) 1947.

27. Rebattu, J.: Thrombo-phlébite du sinus caverneux avec méningite d'origine sinusienne quérie par la pénicilline, Ann. d'oto-laryng. **13**:530 (Nov.-Dec.) 1946.

some degree of edema. There was a mild recurrence of the symptoms a few days later, which, however, disappeared under renewed penicillin therapy. The patient was discharged as cured about a month later, with no permanent loss of function except for a slight persisting paresis of the sixth nerve.

Brethauer [28] had a case of thrombosis of the cavernous sinus in a 27 year old pregnant woman, which was complicated by multiple pulmonary abscesses. The patient received massive doses of penicillin and heparin, and a massive edema developed after five days. Roentgenograms revealed a suppurative sinusitis affecting the left maxillary, frontal and ethmoid sinuses. There was no evidence of osteomyelitis. The patient was apparently cured after four weeks and was discharged from the hospital. One week later there was a recurrence of headaches, fever and vomiting, which receded after therapy of the sinus and with penicillin. A month later, symptoms of cough, fever and general debility led to an examination of the chest, which revealed pneumonitis with cavity formation.

Penicillin was again given, and during this siege, she was delivered successfully. At the time of her discharge from the hospital, five months from the onset of the initial symptoms, there were some residual fibrotic changes in the lungs but no evidence of the previous involvement of the sinus.

ORBITAL AND OCULAR COMPLICATIONS

Smith and Spencer [29] present an interesting analysis of orbital complications resulting from lesions of the sinuses. The symptoms are classified in three groups, those due to inflammatory changes in the orbit, those due to disturbances from mechanical encroachment and, finally, the orbital apex or sphenoidal fissure syndrome. They point out the fact that it is difficult at times to trace the cause to the point of origin, because of the absence of adequate history or findings pointing to the sinuses or because the orbital symptoms overwhelm those due to the sinus lesion. In all cases adequate roentgenologic studies offer the best means of diagnosis, and in many instances the collaboration of the rhinologist, the ophthalmologist and the roentgenologist is necessary to arrive at a successful diagnosis. A number of cases are cited to illustrate the varieties of orbital complications encountered, such as abscess, cellulitis, cavernous sinus thrombosis, mucocele pyocele, osteoma and, in 1 case, involvement of the sphenoid fissure. Also, a case of epidermoid cyst of the frontal bone with aerocele is illustrated to show how confusion

28. Brethauer, E. A.: Thrombophlebitis of the Cavernous Sinus, J. A. M. A. **134**:1090 (July 26) 1947.

29. Smith, A. T., and Spencer, J. T.: Orbital Complications Resulting from Lesions of the Sinuses, Ann. Otol., Rhin. & Laryng. **57**:5 (March) 1948.

might result through mistaking it for a mucocele. The prognosis in most cases has been immeasurably improved since the advent of penicillin, which fortunately is effective in the types of infection usually encountered in these regions.

Viale del Carril [30] goes into great detail describing the anatomy of the sphenoid sinuses in relation to the optic nerves and the probable pathogenesis of optic neuritis from sphenoid infection. He also discusses diagnostic procedures, such as roentgenograms with contrast mediums and puncture irrigation of the sinuses. He claims that recognition of disease of the sinus as a focus is important in the early stages of the optic neuritis because the longer one waits the more irreparable the damage to the nerve. He favors the transseptal route for opening the sphenoid sinuses, as first described by Hirsch and later adapted by Segura, who devised a set of special instruments for the purpose. Two typical cases are cited.

Giovine [31] reports a case of a large mucocele of the sphenoid sinus in a man of 32 which produced an optic chiasm syndrome and affected the sympathetic nerves, causing also Horner's syndrome. The patient suffered severe pain due to pressure on the ophthalmic branch of the trigeminal nerve and diplopia due to involvement of the oculomotor nerve. Vision in one eye was reduced to light perception in the nasal field. The papilla was red and swollen, and there were some retinal hemorrhages in the same area. Vision in the other eye was normal, but hemianopsia was found as well as a mild degree of retinal congestion. Roentgenograms showed considerable distention of the sphenoid sinus, with thinning of the roof, which probably accounted for some pituitary disturbance. The sphenoid sinus was entered by means of a transfrontal craniotomy and the cavity drained of a dark, chocolate-colored fluid. The patient recovered. Reference is made to several similar cases previously reported in the literature.

Sojo Pratdesaba,[32] discussing the possible association of a sphenoid sinus infection with optic neuritis, concedes the fact that in many cases the true origin of the neuritis may be obscure. The causes of optic neuritis are manifold, and it is only when the ophthalmologist fails to locate it that he comes to the rhinologist for investigation of the posterior sinuses. When evidences of infection are manifest, the course of action is simple. The difficulty arises only in cases in which the infection is not demonstrable but is assumed to be occult. In such a case the

30. Viale del Carril, A.: Neuritis ópticas retrobulbares y senos esfenoidales, Rev. brasil. de oto-rino-laring. **13**:260 (July-Oct.) 1945.

31. Giovine, G.: Sindrome visiva ed oculo simpatica da mucocele del seno sfenoidale, Chirurgia **1**:179 (Sept.) 1946.

32. Sojo Pratdesaba, F.: "La trepanación del seno esfenoidal como tratamiento de ciertas neuritis retrobulbares, An. med., Barcelona **34**:56 (Feb.) 1947.

decision as to whether to operate or not must rest with the ophthalmologist. The author recommends the transseptal procedure described by Segura.

Kjaer [33] treated a patient with the orbital apex syndrome due to pansinusitis, a man of 59. This syndrome is rather rare and is characterized by the following:

1. Motor symptoms—paresis of the third, fourth and sixth cranial nerves, with both external and internal ophthalmoplegia and ptosis.

2. Sensory symptoms—impaired sensation in the area of distribution of the three branches of the ophthalmic nerve (lacrimal, frontal and nasociliary).

3. Disturbance of the optic nerve—neuritis, papilledema and amaurosis.

The patient was a 59 year old man who manifested these symptoms over a period of several months before pansinusitis was detected. Two days after a radical external frontoethmoidectomy was done he died. Autopsy revealed suppuration in the sphenoid sinus, with necrotic mucosa. Microscopically, thrombosed vessels were demonstrated in the sinuses and in the vessels about the optic nerve. The connection was unmistakable.

Chalmeton and Reynaud [34] report 2 cases of acute retrobulbar neuritis which were apparently due to involvement of the sphenoethmoid sinuses.

In 1 case frank pus was seen in the nose and prompt opening of the sinuses brought about a rapid recovery of vision. In the other case there were no signs of sinus infection, but the instillation of procaine hydrochloride and epinephrine into the sphenoid sinus resulted in return of vision. Later, a study with iodized poppy seed oil 40 per cent revealed an unusually large sphenoid sinus extending into the sphenoid ala and apparently in close proximity to the optic nerve canal.

Brown [35] is inclined to be conservative in the surgical therapy of the sinuses for the removal of possible foci in cases of retrobulbar neuritis. He would advise exenteration only if local vasoconstrictors and foreign protein therapy fail and the vision is deteriorating rapidly.

Benford and Brunner [36] report 3 cases which show that tumors at the internal angle of the orbit are not always mucoceles and that

33. Kjaer, I.: A Case of Orbital Apex Syndrome in Collateral Pansinusitis, Acta ophth. **23**:357, 1945.

34. Chalmeton and Reynaud: Apropos de deux cas de neurite optique retrobulbaire aiguë, Rev. de laryng. **68**:311 (May-June) 1947.

35. Brown, A. L.: Relation of the Diseases of the Paranasal Sinuses to Affections of the Optic Nerve, Ohio State M. J. **43**:264 (March) 1947.

36. Benford, M. C., and Brunner, H.: Involvement of the Orbit in Chronic Inflammation of the Frontal Sinuses, Am. J. Ophth. **30**:297 (March) 1947.

infections of the sinuses breaking into the orbit do not necessarily have to extend by way of the internal orbital wall. In 1 case there was a pseudotumor of the Birch-Hirshfield type which, on removal, showed masses of lymphocytes in clusters between bundles of muscle fibers. The second case was that of chronic osteomyelitis following trauma, which consisted in a granulating periostitis, which caused the tumor-like formation. In the third case the tumor-like formation was due to a prolapse of thickened frontal sinus mucosa through a perforation in the floor of the sinus. Grünwald [37] points out that the capsule of Tenon forms a more or less complete curtain dividing the orbit into a superficial and a deep portion. Infections limited to the anterior portion are most likely to be accompanied with edema and suppuration, whereas lesions behind the capsule were characterized by exophthalmos and impairment of mobility. The various complications are described in considerable detail.

Alcaíno [38] discusses the avenues of infection passing from the various sinuses to the orbit and the various manifestations according to location and degree. The paper conforms to the usual picture in the textbooks, and the diagnosis and treatment follow standard lines.

Orbital cellulitis due to maxillary sinusitis is rather uncommon in the adult. Fishman and Lebo [39] had a case involving a man of 27 in which, after an acute infection of the upper respiratory tract with maxillary sinusitis, a swelling developed in the lower lid, with redness and later some displacement of the bulb. When this failed to recede under penicillin therapy and irrigations, a Caldwell-Luc operation was performed, which disclosed pus and polypoid mucosa and a dehiscence in the floor of the orbit, through which the orbital accumulation of pus was drained.

Agüero [40] believes that most bronchopulmonary infections secondary to sinusitis are due to aspiration of infected mucus. He points out the importance of careful roentgenologic and bronchoscopic examination and the importance of eliminating tuberculosis. The article is concerned chiefly with diagnosis and medical therapy, with emphasis on bronchial aspiration and the use of aerosol penicillin. No mention is made of surgical treatment nor are any statistics given.

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37. Grünwald, E.: Diagnóstico diferencial de las complicaciones orbitarias inflamatorias de origen sinusal, Rev. otorrinolaring. **6**:193 (Dec.) 1946.

38. Alcaíno, A.: Afecciones orbito-oculares de origen sinusal, Rev. otorrinolaring. **6**:174 (Dec.) 1946.

39. Fishman, V. P., and Lebo, C. P.: Orbital Cellulitis Secondary to Maxillary Sinusitis, Bull. Pract. Ophth. **16**:41 (Dec.) 1946.

40. Latorre Agüero, A.: Diagnóstico y tratamiento de las complicaciones bronco-pulmonares de las sinusitis, Rev. otorrinolaring. **6**:230 (Dec.) 1946.

Adams and Ficarra,[41] analyzing a series of 50 cases of bronchiectasis treated surgically, found an associated sinusitis in 20. They believe that there is a causal relationship but do not go into the question of therapy of the sinuses, the report being confined to the pulmonary aspects of the cases and the results of surgery of the lung.

SINUSITIS IN CHILDREN

Rekling and Worning [42] gave this description of sinusitis in children:

Sinusitis is a disease very often met with during childhood. X-ray examination of 500 children (3-15 years old) revealed a morbidity of 40 per cent (boys 41, girls 38 per cent).

In children 3-5 years of age sinusitis is found more frequently in girls than boys (57 and 37 per cent respectively) whereas boys from 6-10 years old more frequently are affected with the disease than are girls (46 and 27 per cent).

From 11-15 years the incidence of sinusitis is almost the same in boys and in girls (36 and 35 per cent).

The sinus most often attacked is the antrum.

The ethmoidal cells are only attacked in cases of frank sinusitis maxillaris and especially in exudative cases.

Sinusitis frontalis is rare and only found complicating ethmoid sinusitis. Most of the infections of ethmoid and frontal sinuses are rightsided (probably due to the position during sleep).

The incidence of sinusitis throughout the year showed the highest figures in February, March and December, lower figures in January and October and the lowest during July.

Comparing this morbidity with the curves of the average atmospheric pressure, temperature, degree of humidity, precipitation, hours of sunshine and days of frost during the year 1938, the curve of atmospheric pressure completely corresponds to the fluctuation of the morbidity of sinusitis. The only exception is July, during which month the number of cases is extraordinarily small.

The main symptoms of sinusitis in children are protracted and recurring muco-purulent rhinitis, nasal stenosis, coughing, often complicated by a bronchitis. The children are prone to develop tonsillitis and otitis, and they are tired and sluggish, in some cases suffering from headaches. No connection has been found between the clinical symptoms and the roentgenological diagnosis, whether exudative or not.

Pains or tenderness of the maxillary sinus is never seen. Rhinitis vasomotorica disposes to sinusitis contrary to bronchial asthma, allergic eczema, urticaria, rickets and tetany.

Prematurely born children do not seem to be especially disposed to sinusitis.

Adenoids and hypertrophy of the tonsils have been found with equal frequency in diseased children and in healthy ones.

Presumably, the symptoms of sinusitis are not infrequently misinterpreted and thus several children have had tonsils and adenoids removed on false indications.

A child showing the symptoms of protracted, frequently recurring colds combined with coughing that cannot be explained otherwise, chronic rhinitis, nasal stenosis or "facies adenoides" is, most likely, suffering from a sinusitis, and it is advised to examine the sinuses of such a child by x-ray.

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41. Adams, R., and Ficarra, B. J.: Appraisal of Surgery in the Treatment of Bronchiectasis, J. A. M. A. **134**:240 (May 17) 1947.

42. Rekling E., and Worning, B.: Sinusitis in Children, Nord. med. **34**:1381 (June 20) 1947.

Romero Diaz [43] states that sinusitis in nursing infants and young children is frequently overlooked because of the tendency to attribute nasal discharge and obstruction solely to enlarged tonsils and adenoids. He points out that since the antrums and the ethmoid sinuses are present at birth, there is no reason why they may not become infected and give rise to symptoms. He cites Ebbs's report on 430 autopsies in young children, among whom he found 30 per cent giving evidence of sinus disease. Also, he quotes Schoenberg as having found sinus infection in 75 per cent of 232 autopsies on newborn infants. Furthermore, Hooper and Cave found clinical and roentgenologic signs of sinusitis in 90 per cent of all children suffering from scarlet fever. In answer to the question of how important it is to diagnose these conditions, he points out the danger of continuation into a chronic process as well as the possibility of the development of such accompanying sequelae as asthma, rheumatoid arthritis and cardiac disorders. Furthermore, the possibility of osteomyelitis and orbital complications is also to be considered.

Failure to recognize a coexistent sinusitis frequently accounts for disappointing results following removal of tonsils and adenoids in many instances.

The author also quotes Watson Williams on the subject of aprosexia, which he claims is the result of reinfection of the lymphoid tissues in the nasopharynx and pharynx from an undiscovered focus of infection in the sinuses. He goes on then to discuss the history in these cases, emphasizing the importance of analyzing the symptoms of frequent colds, their onset, duration, presence or persistence of fever, discharge, nasal obstruction, cough and gastrointestinal disturbances. The possibility of an allergic factor is given mention.

Examination should be done with the child lying down, with the best possible illumination and the help of a nasopharyngoscope. Roentgenograms are important, and if secretion is present, it should be aspirated and cultured. A cytologic count also should be done.

Concerning therapy, the author stresses first of all the importance of prophylaxis. Children should be shielded from adults suffering from acute infections of the upper respiratory tract since contagion cannot be entirely ruled out. Nose drops must be employed judiciously, keeping well within the limits of a low p_H and a low percentage of concentration. Aspiration of secretions is important. Penicillin and and tyrothricin have a limited use in children, but often do yield good results.

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43. Romero Diaz, E.: Sinusitis del lactante y del niño pequeño, Rev. méd. de Córdoba **35**:213 (April) 1947.

Greenwood [44] discusses the factors predisposing to sinus infection in children, mentioning heredity, environment, diet and allergy. He calls attention to the importance of smears, since diphtheria is often overlooked in the differential diagnosis. Other items to be ruled out are foreign bodies and nasal polypi. Cough, pharyngitis, unilateral conjunctivitis or otitis media are frequent accompaniments of acute sinusitis in children. Collateral edema of the orbit or cellulitis is commonly seen in young children as the result of a suppurative ethmoiditis. Systemic complications such as nephritis, arthritis, diarrhea and loss of weight were noted long ago by Dean. Diagnostic measures should include the use of rhinoscopy, nasopharyngoscopy, cytology, transillumination and roentgenograms. In addition to the customary local shrinkage and drainage, it is important that these children be given adequate pediatric care, since the general therapy is essential in improving the patient's resistance as well as eliminating the predisposing factors.

Gerrie [45] presents a fairly complete analysis of chronic sinusitis in children, based on his experience at the Aberdeen Royal Hospital for sick children. It includes a description of the anatomy, pathology, symptoms, findings and therapy. In all suspected cases the examination should include roentgenograms. Infected tonsils and adenoids should be removed and allergic factors investigated. Lavage of the antrum is recommended if local shrinkage fails to give sufficient relief. He speaks of a "pre-suppurative" stage which can be confirmed by a biopsy specimen from the region of the ostium, in which case the administration of vitamin A may prevent the development of suppurative sinusitis. He advises regular weekly irrigations of the antrum, displacement therapy if the ethmoids are involved, chemotherapy in some cases and surgical intervention only as a last resort.

Offret and Meaux [46] discuss the pathogenesis and development of orbitocranial complications in newborn and nursing infants, based on their observations in 2 patients aged 18 and 1½ months. Redness and edema, with high temperature, led to an early diagnosis of erysipelas in 1 case. When seen a month later, however, the patient had a subperiosteal abscess at the internal angle of the orbit and a draining fistula in the lower lid and in the alveolar recess. The child recovered after several weeks of treatment with sulfonamide drugs and local therapy. In the second case, the month and a half old infant

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44. Greenwood, G. J.: Acute Sinusitis in Children, Illinois M. J. **91**:313 (June) 1947.

45. Gerrie, J.: The Diagnosis and Treatment of Chronic Nasal Sinusitis in Children, M. Press **207** (March 19) 1947.

46. Offret, G., and Meaux, J.: La pseudo-sinusite du nouveau-né et du nourrisson: Étude des manifestations oculaires, Arch. d'ophth. **7**:250, 1947.

had osteomyelitis of the superior maxilla, with fistulas in the alveolar recess discharging pus and later several small sequestrums. The patient made an eventual recovery after having received penicillin injections averaging 40,000 units every twenty-four hours for about a week.

The author reviewed the literature on osteomyelitis of the superior maxilla in infants, and he concludes that in most of these the condition originates in oral infections attacking the alveoli. The antrum is seldom the seat of the primary infection but becomes involved secondarily.

Emhart [47] presents 5 case histories from a series of 22 which he has studied and discusses the problem more or less in detail in relation to etiology, symptomatology and therapy. The presence of osteomyelitic processes in various stages of activity explains latent periods in some cases of chronic sinus disease and reactivation with acute exacerbation. Whether the process begins as periostitis with subperiosteal abscess or primary thrombophlebitis is a question which he believes can only be answered in each individual case. He mentions the shortcomings as well as the value of roentgenologic diagnosis and stresses the importance of the local signs. He also calls attention to the improved prognosis since the advent of chemotherapy, which often limits the amount of surgical treatment required.

Cody [48] reports a case of osteomyelitis of the frontal bone due to acute frontal sinusitis in a 14 year old boy and complicated by a large extradural abscess. The affected area was well exposed through a coronal incision and reflection forward of the soft tissues overlying the entire frontal area. Both sinuses were affected, and after the epidural accumulation of pus was released it was noted that the dura was covered with granulations for some distance beyond the diseased bone. In the author's opinion this was probably the result of extension by way of the communicating veins. He points out the importance of adequate exposure and removal of the entire thickness of the bone lest the remote foci be overlooked.

Kahn [49] reports a case of a young soldier who had sustained several penetrating wounds of the face from Japanese mortar shell fire. He was suffering from severe hemicrania and had sustained several severe hemorrhages from the nasopharynx. Despite repeated postnasal packs

47. Emhart L, O.: Osteomielitis del hueso frontal como complicación de sinusitis, Rev. otorrinolaring. **6**:24 (Dec.) 1946.

48. Cody, C. C.: Acute Frontal Sinusitis with Intracranial Complication, M. Rec. & Ann. **31**:113 (March) 1947.

49. Kahn, K. M.: Osteomyelitis of the Sphenoid Bone, Arch. Otolaryng. **45**:348 (March) 1947.

and the administration of large doses of penicillin the hemorrhages continued. Roentgenograms revealed extensive disease of the frontoethmoid sinuses and probable osteomyelitis of the sphenoid bone. An external operation revealed extensive necrosis of the frontal bone, exposing the brain and extending back to the sphenoid, whose anterior and superior walls were also necrotic. Removal of a clot from the sphenoid sinus was followed by a massive hemorrhage. The common carotid artery was ligated, but this failed to prevent a subsequent severe hemorrhage. The internal carotid artery was then tied off, and the bleeding ceased. The patient recovered after receiving numerous blood transfusions and large doses of penicillin. There were no cerebral symptoms following the ligations.

Watson [50] demonstrates the efficiency of penicillin in a case of frontal sinusitis with the development of osteomyelitis in a boy of 13 a few days after swimming. The nasal discharge contained hemolytic streptococci. An abscess in the midline of the forehead was evacuated and the underlying bone explored, but no fistula into the sinus was found. The author believes that the abscess was due to a thrombophlebitis of the communicating veins from the mucoperiosteum lining the sinus to the diploetic veins. The patient received a total of 850,000 units of penicillin over a period of two weeks.

Spar and Williams' [51] case is the first of its kind reported in which recovery occurred. The osteomyelitis involved the base of the sphenoid and occipital bones, with suppuration and involvement of the meninges and the eighth, ninth and twelfth cranial nerves and also of the motor division of the fifth. The symptoms had been developing over a period of nine weeks following the use of nasal and postnasal packs for the control of hemorrhage. The packs had been employed for a period of two weeks. The organism recovered was the anaerobic streptococcus. Recovery followed as a result of continuous intravenous administration of penicillin, together with sulfadiazine by mouth. Also, 4,000 mg. hours of radium were directed to the nasopharynx, although later biopsy proved that the lesion was not malignant. The authors believe that the infection originated in the nasopharynx after trauma and stasis due to prolonged packing that impaired the circulation of the periosteal covering of the bone which depends on this layer for its nourishment.

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50. Watson, D.: Case of Bilateral Frontal Sinusitis with Osteomyelitis of the Frontal Bone and Left Antral Sinusitis, Treated with Penicillin, J. Laryng. & Otol. **61**:310 (June) 1946.

51. Spar, A. A., and Williams, H. L.: Osteomyelitis of the Basisphenoid and Basiocciput with Meningitis and Cranial Nerve Palsies as a Complication of Nasopharyngeal Packing for Control of Epistaxis: Report of Case with Recovery, Arch. Otolaryng. **46**:473 (Oct.) 1947.

Rasquin [52] relates a case of osteomyelitis of the frontal bone in a boy of 16 apparently following an acute infection of the upper respiratory tract. It developed rather slowly during a period of one month and was demonstrated in roentgenograms at a time when the subjective and local symptoms seemed to be subsiding. A large area of infected bone was removed through a coronal incision, and this was followed by definite improvement. However, about three months later the patient manifested signs of intracranial involvement, such as euphoria, impaired mentality and incontinence. There were also some ocular disturbances. A large superficial abscess of the frontal lobe was uncovered and drained. The patient recovered except for the incidence of jacksonian fits which, however, disappeared in time. He was followed for a period of almost three years, during which time considerable regeneration of bone in the operated area was observed.

MALIGNANT TUMORS

Wille [53] analyzes the results in a series of 220 cases of a malignant process involving the antrum and the ethmoid sinus, observed at the Norwegian Radium Hospital from 1932 to 1944. A large proportion of patients were in a rather advanced stage of disease, which in part accounts for the generally poor results obtained: 39.6 per cent had external fistulas when first seen, 35.5 per cent had glandular metastasis and 30 per cent had some involvement of the bulb, such as protrusion, closure of the palpebral fissure or fixation. The earliest symptoms noted were nasal obstruction (41), pains in the teeth or jaw (38), pains in the eye, jaw or temple (32), swelling of the cheek (27) and nasal discharge (21). Previous infection of the sinuses as a contributing factor could not be estimated because the number in which such a history could be elicited was minimal and because secondary inflammatory changes obscured the picture. Roentgenologic diagnosis was of the utmost importance. Two hundred and ten patients showed destruction of bone or operative defects from previous surgical treatment.

Most of the cases were of carcinoma (73.6 per cent). Sarcoma was infrequent (6.8 per cent).

The highly differentiated types seemed to offer the best prognosis, especially if suitable for radical operation. The best results were obtained in a group of 33 cases in which radical resection of the maxilla was performed; 36.4 per cent of the patients survived three years, 18.1 per cent five years and 6 per cent ten years. The author had several cases

52. Rasquin, P.: Un cas guéri d'ostéomyélite des os du crâne, Acta oto-rhino-laryng. belg. **1**:67, 1947.

53. Wille, C.: Malign Tumors in the Nose and Its Accessory Sinuses, Acta oto-laryng., 1947, supp. 65, p. 1.

in which recurrence was noted as late as ten years. Of a group of 64 patients receiving combined surgical treatment and irradiation (Denker or Caldwell-Luc operation) 26.6 per cent obtained cures for three years, 14 per cent for five years and 1.6 per cent for ten years. Ninety-five received irradiation therapy only. Of these, 23.7 per cent survived three years, 11.4 per cent five years and 2.3 per cent ten years. Ocular disturbances were noted in the vast majority of patients receiving heavy irradiation, the most frequent sequel being an involvement of the lens.

The author describes the various methods of administering roentgen and radium therapy which were tried over the period of years and seems to favor fairly large doses over several fields during a comparatively short time. It is difficult to draw conclusions from his evidence because of several factors, namely, the advanced state of the growth, presence of orbital complications and a variety of combinations of roentgen and radium technics.

Coutinho [54] discusses malignant tumors of the superior maxilla and follows Ohngren's classification according to location, using a line drawn from the internal canthus to the angle of the jaw. The superior half is again divided into an external and an internal half. The diagnosis and prognosis naturally vary widely according to the site of the growth, as has been pointed out numerous times in the literature. The author lists four types as follows: (1) ocular, characterized by involvement of the orbit with proptosis and exophthalmos; (2) neuritic, characterized by severe radiating pains due to compression of the infraorbital nerve, often mistaken for true trigeminal neuralgia; (3) nasal, in which obstruction, discharge and polypoid formation are found, and (4) dental, with pains in the teeth, decay and involvement of the alveolus and palate.

When possible the tumor should be eradicated by means of surgical intervention and diathermy, preferably through a sublabial or palatal approach. In some cases, however, a wider resection through the face is necessary, involving considerable mutilation. This is of secondary importance, since plastic repair can restore a reasonable semblance of normalcy if the patient recovers.

The author has found irradiation of value only as supplementary to sugical treatment or for postoperative recurrences.

Munson and Munson [55] report a case of adenocarcinoma of the ethmoid sinus in a woman of 49. There was a history of nasal obstruction for about a year. Polyps had been removed some three months previously. Transillumination and roentgenograms revealed considerable darkness in the maxillary, frontal and ethmoid sinuses of the

54. Coutinho, A.: Câncer dos seios maxilares, Hospital, Rio de Janeiro **31**:[397b], (March) 1947.

55. Munson, F. T., and Munson, H. T. E.: Adenocarcinoma of the Ethmoid Sinus, Arch. Otolaryng. **45**:581 (May) 1947.

left side. A Caldwell-Luc operation was performed, and friable vascular fungating masses were removed from the ethmoid sinus, the maxillary sinus having been found free of neoplasm. Since the tumor was under suspicion of being malignant and could not be exenterated through the transantral approach, an external frontoethmoid operation was done. The growth was found to extend toward the frontal and sphenoid sinuses. The exenteration was followed by surgical diathermy. Histologically, the specimen was typically an adenocarcinoma. Clinically, the patient was free from evidence of recurrence at the end of thirty-one months.

Tassman's [56] case involved a woman of 58, whose early symptoms were headache and recurring epistaxis. The pains increased in severity, and soon there developed ophthalmoplegia with edema of the upper lid. Early roentgenograms failed to reveal any abnormalities. An exploratory operation on the orbit also yielded no evidence. Later roentgenograms showed loss of outline of the posterior wall of both sphenoid sinuses and general haziness. An external sinus operation was performed, exposing the antrum and the ethmoid and sphenoid sinuses. It revealed an extensive malignant process in the ethmoid and sphenoid sinuses, with loss of the bony posterior wall of the latter. The histologic report was "necrotizing hemorrhagic, suppurative carcinoma invading the lymphatic vessels and vascular channels, probably primary in one of the nasal sinuses." Transfusions and roentgen ray therapy were administered, with considerable relief and regression of the symptoms. There was no report on the subsequent course of the case.

Portman and Beillard [57] present an extensive discussion on the histopathology and clinical characteristics of neurogenic tumors of the nose which are primary. These are divided into two groups, neuroepitheliomas and gliomas. The former may be neurospongial or neuroblastic, developing from primitive neural elements. The latter, however, develop from adult neuroglia or from neurospongial cells that have reached a certain stage of development. They claim to have found only 21 cases reported in the literature, of which 14 were cases of gliomas and 7 cases of neuroblastomas. Thirteen of the case histories are abstracted in the article. The one case which came under their own observation is given in considerable detail. It involved a child of 11. The first symptoms noted were nasal obstruction and epistaxis and displacement of the bulb. A mass was seen occupying the entire nasal fossa. The antrum was cloudy. Biopsy revealed mostly a richly cellular tumor of epithelial character, whose exact nature could not be deter-

56. Tassman, I. S.: Complete Unilateral Ophthalmoplegia Due to Primary Carcinoma of the Sphenoidal Sinus, Arch. Ophth. **37**:294 (March) 1947.

57. Portman, G., and Beillard, P. F.: Les tumeurs nerveuses des fosses nasales, Rev. de laryng. **68**:1 (Jan.) 1947.

mined although it was thought to be extremely malignant. A transmaxillonasal operation was performed, and a soft vascular mass was removed from the nasal cavity, antrum and ethmoid sinus. Histologic examination revealed a vascular and cellular growth, resembling a round cell sarcoma. There was rapid recurrence of the growth, which led to a second operation in which the orbit was exenterated and all the sinuses cleaned out. There was no dehiscence leading into the cranial cavity and therefore no connection with the endocranium. The patient succumbed within twenty-four hours. A detailed report of the histopathologic nature of the tumor is given, with the conclusion that it was a "sympathoma" or sympathoblastic growth. The cells in no way resembled the neuroepithelium of the olfactory nerves but were more nearly like the embryonal type found in the sympathetic elements.

Beatty [58] reports the results in 40 cases of malignant growth of the nasal sinuses. There were 4 postoperative deaths, 9 recurrences, 6 cases of metastasis and 5 deaths from other causes. Five patients were alive and well, and 7 were not traced. Unfavorable results in most cases were due to the advanced stage of the growth when the patient was first seen. The author advises radical operation, with postoperative irradiation.

NONMALIGNANT TUMORS

De Juan's [59] case concerned a man of 24 who for more than a year complained of lacrimation, periorbital pain and slight exophthalmos. Palpation revealed a hard mass at the internal angle of the orbit. Roentgenograms confirmed the diagnosis of an osteoma of the ethmoid sinus. The author claims that osteomas of the ethmoid sinus are half as frequent as those of the frontal sinus. In this case the tumor blocked the nasofrontal duct, causing a mucocele of the frontal sinus. There was no history of previous trauma. The mass was removed through an external incision exposing the lacrimal sac, which was displaced to afford access to the tumor. It measured 4.5 by 2.5 cm. and weighed 20 Gm., and it was partly dense and partly spongy. Recovery was uneventful.

In 1 of Moore's cases [60] a small osteoma of the frontal sinus increased in size over a period of nine years, sufficiently to give rise to decided symptoms due to secondary infection and obstruction to drainage. It was relieved by an external operation. Diplopia disappeared in two months.

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58. Beatty, H. S.: Cancer of the Larynx and Nasal Accessory Sinuses, Ohio State M. J. **43**:843 (Aug.) 1947.

59. de Juan, P.: Osteoma etmoidal derecho con mucocele frontal, An. Casa de salud Valdecilla **10**:15, 1947.

60. Moore, P. M.: Osteoma of the Frontal Sinus, Cleveland Clin. Quart. **14**:17 (Jan.) 1947.

In a second case, in which there was an acute infection of the upper respiratory tract with swelling of the right eye, the patient recalled an acute frontal sinusitis six years previously which had subsided under conservative treatment. Roentgenograms revealed a large osteoma, apparently springing from the ethmoid sinus but occupying about half of the frontal sinus. A local accumulation of pus was relieved by an incision, and after the acute symptoms had subsided the mass was removed at a second operation. It had eroded part of the floor and outer plate of the sinus and weighed 17 Gm., measuring 4 by 2 by 3.5 cm. The patient recovered.

Foque [61] reports a case of osteoma involving the anterior ethmoid sinuses in a woman of 33. It had grown slowly without pain or discomfort over a period of years, causing only a slight displacement of the bulb outward and downward. Roentgenograms confirmed the diagnosis and revealed the mass posterior to the frontal sinus and below the roof of the orbit at the superointernal angle. It was successfully removed through the usual external incision. The superior oblique muscle was found incorporated in the bony mass and had to be sacrificed, with a resultant diplopia. There was no history of earlier trauma.

Novick [62] believes that the type of the osteoma is determined by the age at which it develops and the type of tissue from which it originates. A rapidly growing tumor, known as an ossifying fibroma, is composed of fibrous connective tissue and osteoid bodies. A slowly growing tumor, called spongy osteoma, consists of spongy bone. The compact osteoma is made up of compact bone with haversian systems. The author shows a number of illustrations demonstrating how bone develops from connective tissue, from cartilage and from membrane. Since the osteoma can develop during any of the transitional stages of bone formation, its consistency will vary with the consistency of the bone at a particular stage. He cites a case of a woman of 48 in whom the dense mass was found attached to the posterior plate of the frontal sinus by a broad base. It was removed piecemeal, and a good result was obtained.

A case of osteoma described by de Unamuno Lizárraga [63] concerned a young woman who complained of severe hemicrania for two years. More recently, loss of vision and exophthalmos appeared. Roentgenograms showed a tumor occupying the orbit and the posterior part of

61. Foque, G.: Un cas d'ostéome de l'ethmoide, Rev. de laryng. **68**:380 (July) 1947.

62. Novick, J. N.: Osteoma of the Frontal Sinuses, Arch. Otolaryng. **46**:655 (Nov.) 1947.

63. de Unamuno Lizárraga, R. R.: Osteoma de la órbita, con alteraciones visuales bilaterales, An. Casa de salud Valdecilla **9**:503, 1946.

the nasal cavity. An orbitotomy was performed; the internal rectus muscle was sectioned and the inferior oblique muscle displaced, thus exposing the deeper portion of the orbit near the apex, where the mass was encountered between the optic nerve and the internal wall of the orbit. It was readily removed and proved to be a rather smooth, dense, bony mass measuring 3 by 2.5 cm. and weighing about 26 Gm. The postoperative course was uneventful.

Leegaard [64] says that mucocele is, on the whole, a benign disorder, affects mainly the frontal and ethmoid sinuses and develops slowly for years. The continued or periodic blocking of the passage to the nose which causes the distention of the cavity and thinning of the bone wall is ascribed partly to trauma, especially in the case of the frontal sinus, and partly to inflammatory changes in the mucosa. Often medical aid is sought only when dislocation of the eye results; it may be marked, and double vision may occur. If the secretion becomes infected, because of acute rhinitis, and an empyema is formed, sudden aggravation may set in. Treatment is operative and consists in creating free access to the nasal cavity.

In the first case described, that of a woman aged 58 with mucocele in the frontal sinus of twenty years' duration infected during the last half year, the eye was forced downward and outward, extending like a pear-shaped tumor to the canthus externus. Radical operation according to the method of Bárány gave good results, but considerable exophthalmos remained. In the next case, that of a boy aged 17, a lump on the forehead was noticed five weeks earlier. Radical operation (Bárány) revealed in a sac in the frontal sinus a free bony pea-sized body, possibly of traumatic origin and possibly a free osteoma, thought to explain the obstruction. In the third case, involving a man aged 25, the lump on the right side of the forehead observed for five years increased in size, and there was occasional purulent discharge from the right side of the nose. Radical operation (Bárány) was done. The blocking was probably of intermittent kind, the cause unknown. The last case involved a man aged 47 with gradual aggravation of the exophthalmos of the left eye, present for two or three years. Roentgenologic examination showed an osteolytic process of walnut size in the left frontal bone. The clinical diagnosis was mucocele. The histologic diagnosis of the tumor removed from the orbit was xanthomatous infiltration. The definite hypercholesteremia which was found might, in spite of the patient's age, point to Schüller-Christian disease. Localization in the inner organs, not now demonstrable, cannot be excluded.

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64. Leegaard, T.: Mucocele, Nord. med. (Norsk mag. f. lægevidensk.) **26**:995 (May 11) 1945.

Pendergrass and Kirsh [65] present 3 interesting cases, in 1 of which was a large mucocele involving the orbit, frontal, ethmoid and maxillary sinuses in a woman of 74. The patient had fallen down a flight of stairs fifteen years previously, and swelling had appeared over the eye a few months later. The mass increased in size slowly for the next six months, when its growth accelerated rapidly, pushing the eye outward and downward. It became soft and ruptured spontaneously, releasing a quantity of foul-smelling brownish material. The patient was in poor physical condition at this time, and the mass was partly gangrenous. Roentgenograms showed extensive destruction of bone about the orbit and sinuses. The mass was excised by surgical diathermy and the orbit exenterated. This left a smooth, shiny cavity, which was 10 by 12 cm. across and 14 cm. deep. The patient died a month later of a cerebrovascular accident. In addition to the roentgenograms the authors present some excellent colored photographs and photomicrographs, which greatly heighten the value of the presentation.

Taptas [66] contends that solitary polyp of the nose, whether reaching the choana or remaining within the nasal cavity, is a monocystic degeneration of the maxillary sinus mucosa in the form of a mucocele that forces its way through the thin nasoantral wall of the middle meatus below the natural ostium. Similarly, he concludes that frontal mucocele is a glandular cyst that has eroded through the thin-walled floor into the orbit.

Muscettola [67] reports 7 cases of mucocele of the ethmoid and frontal sinuses, laying particular emphasis on the value of good roentgenograms in the diagnosis. The signs are rather constant, consisting of moderate opacity of the sinus, circumscribed area of hypertransparency, distention of the sinus cavity with some blurring of its outlines and frequently partial absorption of the bony partitions. The roentgenograms accompanying the article show a variety of mucoceles of varying sizes and locations, all well defined and certainly easily recognizable.

Brunner and Savitt [68] demonstrate the fact that mucoceles apparently originating from the frontal sinuses may in fact be due to forward expansion from an orbitally situated frontoethmoid cell. In 1 case it appeared in the region of the glabella sixteen years after what appeared to have been a Lothrop operation. When this was exposed, there was

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65. Pendergrass, E. P., and Kirsh, D.: Roentgen Manifestations in the Skull of Metastatic Carotid Body Tumor (Paraganglioma), of Meningeoma and of Mucocele: Report of Three Unusual Cases, Am. J. Roentgenol. **57**:417 (April) 1947.

66. Taptas, N.: Mucocèle du sinus maxillaire: Polype solitaire du nez, Ann. d'oto-laryng. **13**:333 (July-Aug.) 1946.

67. Muscettola, G.: Il quadro clinico-radiologico del mucocele fronto-etmoidale, Riv. oto-neuro-oftal. **22**:103 (March-April) 1947.

68. Brunner, H., and Savitt, L.: Mucoceles of Frontal and Orbital Cells, Ann. Otol., Rhin. & Laryng. **56**:917 (Dec.) 1947.

evidence of chronic osteomyelitis with some sclerosis and the mucocele was found to have originated in an orbital cell eroding through the posterior wall of the frontal sinus. In the second case the mucocele had formed in a cell located below the floor of the frontal sinus, into which it had eroded.

In 1 of the 2 cases reported by Morman,[69] the mucocele was extensive and caused considerable prominence of the upper jaw. Being rather firm in substance, it was considered a possible carcinoma. A puncture of the antrum was done, which was followed by the discharge of a large amount of thick brownish fluid. Iodized poppy seed oil 40 per cent was injected into the cystlike cavity, outlining its smooth round contour. The mass was exposed through a horizontal incision extending laterally to the zygomatic arch and was found to be filled with the same brownish fluid. It was dissected out from the bone and appeared to have eroded the infraorbital ridge as well as a large portion of the lamina papyracea. The cavity was lined with mucosa. Subsequently the antrum was opened through a Caldwell-Luc procedure and its lining found to be thickened. The sinus cavity was small.

In the second case the mucocele was more of the typical fronto-ethmoid type and was exenterated through a radical external fronto-ethmoidectomy.

The author concludes that the diagnosis in all these cases cannot be established fully by roentgenologic and pathologic study and frequently one has to give full consideration to the clinical findings. The pathologist's report in both cases was "chronic inflammation."

Aschan's [70] patient was a woman of 49 who, several years previously, had had an upper molar root extracted, which left a draining fistula. Roentgenograms showed a large smooth mass occupying most of the antrum. A Denker approach uncovered the cyst, which had a bony wall measuring about 2 to 3 mm. in thickness. It tapered down to the alveolar fistula, which was filled with granulations and contained a small remnant of the tooth root. The sinus mucosa was normal. The alveolar fistula was closed later by a plastic operation.

A case of median anterior maxillary cyst containing a supernumerary incisor tooth is reported by Austin.[71] It involved a man of 36, who suffered pain and swelling in the region of the central incisor teeth for several years. It was removed through a palatal incision extending from second premolar to second premolar. The bone in the region of the anterior palatine canal was thinned out to a point where the sac

69. Morman, W. D.: Mucocele of the Fronto-Ethmoid Area, Ann. Otol., Rhin. & Laryng. **56**:927 (Dec.) 1947.

70. Aschan, G. K.: Eine seltene Form von intrasinusaler Wurzelspitzenzyste, Acta oto-laryng. **35**:592, 1947.

71. Austin, L. T.: Median Anterior Maxillary Cysts Complicated by Supernumerary Central Incisor, Am. J. Orthodontics **33**:618 (Aug.) 1947.

wall was adherent to the mucosa of the palate. Perforation resulted, with expulsion of a thin dark-colored fluid. Histologic examination of the cyst wall showed remnants of stratified epithelial lining and hemorrhage into the walls.

Stafne [72] reports a case of anterior palatine cyst in a woman of 29, which presented as a bulging mass in the midline labial region extending from the nasal spine to the alveolar crest. It had developed in the course of a few weeks, causing considerable pain and discomfort. It was removed through an incision on the labial surface, about 1 cm. above the gingival margin. The author states that cysts in this region usually develop from epithelial remnants in the incisor canals. As a rule they grow in a backward direction and are more readily removed through the palate. The case cited was an exception.

In the second case reported by Stafne a 15 year old boy presented an infection in the upper incisor region dating back some weeks to a periapical abscess which had been incised and drained. There was a history also of a fracture of the crown of the tooth eight years previously and some subsequent therapy of the root canal. Roentgenograms revealed a cystic mass between the lateral incisor and the canine teeth. It was removed through a labial incision without disturbing the adjacent roots, and later roentgenograms showed the cavity being obliterated by new bone formation. Histologic examination showed the cyst to be lined with stratified squamous epithelium.

The author believes that this cyst is due to incomplete closure of the globular and maxillary processes and may be analogous to the formation of cleft palate and harelip.

Shea [73] calls attention to the necessity for pathologic reexamination of all nasal growths resembling polyps and advises caution in attributing these growths categorically to allergy. By way of illustration he cites 8 cases. In 1 case cerebrospinal rhinorrhea with fatal meningitis was found at autopsy to have been due to rupture of an inflammatory polyp into the anterior cranial fossa. In other cases the growths included a lymphangioma, a hemangioma, a cholesteatoma, a plasmocytoma and a transitional cell carcinoma.

Hollender [74] claims that antiallergic therapy will not always prevent the recurrence of nasal polyps after surgical removal and advises radium therapy or zinc ionization. Since the former involves some expense he favors the latter in most cases and reports 55 of 72 patients thus

72. Stafne, E. C.: Median Anterior Palatine Cyst: Report of a Case, Am. J. Orthodontics **33**:592 (Aug.) 1947; Globulo-Maxillary Cyst: Report of a Case, ibid. **33**:595 (Aug.) 1947.

73. Shea, J. J.: The Pathology of Nasal Polyps and Related Growths, Ann. Otol., Rhin. & Laryng. **56**:1029 (Dec.) 1947.

74. Hollender, A. R.: The Prevention of Recurrence of Nasal Polyps, Ann. Otol., Rhin. & Laryng. **56**:932 (Dec.) 1947.

treated completely cured and 10 partially relieved. In a series of 65 patients treated with radium 47 were cured. He claims that ill effects such as anosmia and severe reactions have not been apparent in his experience with several thousand treatments.

De Andrade Medicis [75] presents a review of the literature in choanal polyp and finds that most authors agree that the characteristics of this growth are that they are (1) unilateral, (2) solitary and (3) have a long pedicle leading into a sinus, usually the maxillary. Also, it is found more commonly in children than in adults. He cites 7 patients ranging in age from 10 to 30, 5 of them being between 10 and 12 years of age. In all but 1 case the operation was performed on the antrum and the pedicle traced to various locations within the sinus, more frequently in the orbital recess. Pus was encountered only once. Mostly the membrane was edematous and a serous type of secretion was found, which leads one to suspect that in all these cases the condition was on an allergic basis.

Gisselsson [76] cites a case of a boy of 15 in whom a tumor resembling a nasal polyp was removed and proved to be an encephalomeningocele. Meningitis followed, which was cured by administration of antibiotics. Subsequent rhinorrhea was stopped by an operation. Through an external incision the frontal sinus was opened and found normal. The ethmoid labyrinth was entered and some polypoid tissue found. The lamina cribrosa was exposed, and a dehiscence measuring 3 by 5 cm. was uncovered, from which the fluid was dripping. It was widened until healthy dura was found. The dehiscence was covered with some muscle tissue taken from the frontalis and then covered with mucosa derived from the middle turbinate. The wound was dusted with sulfathiazole powder.

The author collected 34 cases of intranasal encephalocele from the literature and gives some brief abstracts of the most noteworthy.

In any case in which a solitary growth is found high up in the nasal cavity, with a history of obstruction going back to childhood, one should hesitate before snaring it off. The author advises a wide exposure in such cases to determine its origin.

Zwergius [77] reports a case of xanthomatosis of the orbit in a girl of 12. Exophthalmos had been noted for the past five years. At first it was diagnosed as a mucocele, but operation failed to disclose any pathologic changes in the ethmoid cells. Later the density of orbital shadows increased and the exophthalmos became greater, which led to a second

75. de Andrade Medicis, J.: Polipos de Killian, Rev. brasil. de oto-rino-laring. **13**:297 (Nov.-Dec.) 1945.

76. Gisselsson, L.: Intranasal Forms of Encephalo-Meningocele, Acta oto-laryng. **35**:519, 1947.

77. Zwergius, E.: Xanthomatosis Caused by Hand-Schüller-Christian's Disease, Acta oto-laryng. **35**:596 (Jan.) 1947.

operation, at which time the growth was found in the roof of the orbit, seeming to resemble an osteoma. Most of it was removed, and the patient then received a number of roentgen ray treatments. When the patient was seen several years later the exophthalmos was more pronounced. The roentgenograms did not reveal any bony destruction, and there were no evidences of diabetes insipidus. The patient seemed practically normal.

In a second case described by the same author a man of 41 had exophthalmos over a four year period without any other complaint. Roentgenograms seemed to indicate a mucocele of the ethmoid sinus. Operation disclosed a firm tumor of the orbital roof which contained yellowish brown masses, crystals and foreign body giant cells. The serum cholesterol level was 400 mg. per hundred cubic centimeters. The patient was given roentgen ray treatments and a low cholesterol diet. The further progress of the case was not mentioned.

In discussing the diagnosis the author is unable to account for the pathogenesis in the absence of symptoms of cholesterol-producing diseases. The presence of chronic inflammatory changes also obscures the picture. He believes that the prognosis is unfavorable.

Jacod and Bussy [78] report a case of myelogenous tumor in the ethmoid sinus in a 20 year old youth. This is a rarity, since most of these growths occur in the long bones or in the alveolar process of the maxilla. The early symptoms were unilateral nasal obstruction and exophthalmos. The progress of the growth was slow over a period of several years. There were no decided symptoms other than those just noted—no diplopia, no pupillary disturbance and no general symptoms. The mass was palpable at the internal wall of the orbit in the lacrimal area, was not particularly tender and extended along the side of the nose. It was seen on intranasal examination pushing the middle turbinate against the septum. Roentgenograms showed cloudiness of most of the sinuses and the ethmoid area replaced by a semiopaque diffuse mass. It was removed through an external incision, which afforded access to the frontal and maxillary as well as the ethmoid sinus. The tumor was found in the ethmoid sinus extending into the orbit, was firm, irregular and dark in color. It seemed to spring from the ascending process of the superior maxilla and the orbitomaxillary arch and extended back as far as the sphenoid sinus, which, however, was not involved. When removed it was the size of a small egg. The operation left a large depression which would require an osteoplastic procedure for correction. Histologically, the tumor showed thin osseous tissue peripherally, enclosing a fibrous mass which was firm and homogeneous, with cells usually seen in the ordinary myelogenous tumors of the long bones.

78. Jacod, M., and Bussy, J.: Les tumeurs à myéloplaxes de l'ethmoïde, Ann. d'oto-laryng. **13**:337 (July-Aug.) 1946.

The case reported by Fernandez Canepa, Corsellas and Lascano Gonzales [79] is the third of its kind in the Argentine literature. It involved a boy of 14 who gave a history of an allergic episode dating back to his fifth year in which there was an edematous swelling over the right eye, accompanied with local itching which disappeared in about twelve hours. The authors attach much significance to this phenomenon in the cause of the growth, which had first been noted several months previously. It began with severe supraorbital pain and edema and no evidence of conjunctival infection. Roentgenograms revealed an area of bone loss near the external portion of the supraorbital border, which had a punched-out appearance. Biopsy revealed a pale, friable, vascular mass which on histologic examination showed masses of eosinophils and some giant cells.

Chemotherapy failed to offer any relief. High voltage roentgen ray therapy in divided doses for a total of 2,500 r was followed by prompt recession of the growth, with disappearance of all local symptoms. Follow-up roentgenograms showed the bony defect filling in with new bone.

The authors believe the condition to be a distinct entity, having no relationship to the Hand-Christian-Schüller syndrome.

Lascano [80] reports the same case in another periodical and adds the following data. The growth was fixed to the overlying skin, and roentgenograms revealed an erosion of the underlying frontal bone. Only the superficial portion was removed because the base was found to be firmly attached to the meninges. The mass removed had a pale gray appearance, was friable and partly encapsulated. It was found to be extremely vascular and contained areas of necrosis. Masses of eosinophils were seen in the rich network of the reticulum and here and there a giant cell. The most significant finding, according to the author, was the presence of numerous pyramidal-shaped crystals. The author believes that the presence of these crystals merits classification of the tumor as a distinct form of eosinophilic granuloma rather than a variation of the Schüller-Christian syndrome, although basically they both may be due to the same cause.

Buzoianu and his co-workers [81] operated on an extensive nasopharyngeal fibroma which had invaded the nasal cavity, maxillary sinus

79. Fernandez Canepa, J. R.; Corsellas, M. F., and Lascano Gonzales, J. M.: Granuloma eosinofilo del frontal, Radiología **9**:34 (Jan.-June) 1946.

80. Lascano, E. F.: Hallazgo de cristales especiales en un case de granuloma eosinófilo, Arch. Inst. cir. prov. Buenos Aires **1**:656, 1946.

81. Buzoianu, G.; Baida-Voevod, A., and Crisan, V.: Iterative Vestibulo-Buccal Operation as Technical Procedure in the Eradication of Rhino-Pharyngeal Fibromata Extended to the Maxillo-Ethmoido-Zygomatic Region, Rev. sc. otorhino-laryng. **10**:115 (July-Oct.) 1946.

and zygomatic fossa by way of a Denker approach. Because of severe hemorrhage only a portion of the mass could be removed, and three or four successive operations had to be performed through the same incisions for complete removal. After each operation the patient received a blood transfusion and the cavity was tightly packed. (One wonders why surgical diathermy was not employed or the vascularity reduced by the implantation of radium needles.—S. S.)

Portmann and Heyraud [82] detail the history in a case of chondroma involving the palate, nasal cavity, maxillary sinus and entire side of the face in a woman of 57. The patient had been under observation at various times during a period of twenty-three years. The onset was noted to have followed a cold, during which the patient had severe headaches and orbital pains, nasal discharge and lacrimation. These symptoms recurred at intervals, and it was only after the lapse of nine years that a tumor was discovered in the hard palate and nasal cavity, which on biopsy was found to be a chondroma. Nothing was done, however, until some twenty years after the onset, when the growth had reached such proportions as to force the patient to keep her mouth open. Also, it bulged out through the cheek, and the nose was completely blocked. It was removed by way of an external incision of the Moure type, which left a large defect in the maxillopalatal area. Complete extirpation was not possible because the growth had invaded the roof of the nasopharynx and the posterior wall of the antrum.

However, a good primary result was obtained, since the patient was again able to eat properly and breathe through her nose.

The authors devote considerable space to a general review of the subject.

Klimpel [83] reports a case of papilloma of the maxillary sinus in a man of 54. There was a history of mucopurulent discharge and some headache. A few small polyps were seen in the nose, and irrigation of the antrum yielded a sanguineous fluid. At operation the antrum was found to be filled with masses of papillomas which bled freely but were easily removed. The process extended into the middle meatus and the ethmoid sinuses. Histologically the growths were diagnosed as papilloma dura, and the patient was sent to the Cancer Institute, although there was no pathologic evidence of malignant changes.

(To Be Continued.)

82. Portmann, G., and Heyraud, J.: Le chondrome du massif facial, Rev. de laryng. **69**:1 (Jan.) 1948.

83. Klimpel A., L.: Papiloma del seno maxilar, Rev. otorrinolaring. **7**:200 (Dec.) 1947.

FUNCTIONAL EXAMINATION OF HEARING

ALFRED LEWY, M.D.
SHERMAN L. SHAPIRO, M.D.
AND
NORMAN LESHIN, M.D.
CHICAGO

THE CONSERVATION of hearing and the rehabilitation of those handicapped by impairment of hearing, which made great progress in the medical department of the armed forces, are being extended to civilian life to a greater degree than before. The study of hearing tests in relation to speech and the functional examination of hearing for the fitting of hearing aids constitute the subjects of a considerable portion of the articles reviewed. Much of this work is being done by well qualified audiologists other than doctors of medicine. Foreign literature is becoming more available.

TESTS

The Committee on the Conservation of Hearing reports their recommendations and method of recording audiometric results.[1] Their suggestions are based on the results of a questionnaire sent to a large number of audiologists. The audiometric chart prepared by Fowler and Sabine conforms to all the recommendations contained in this report. The method of computing hearing loss from this chart gives a figure which represents the capacity to hear speech. Information about this chart may be obtained by writing to the Council on Physical Medicine of the American Medical Association. Audiometric charts should have the following uniform points: The chart should be simple and clear and should have all the test frequencies of accepted commercial audiometers from 128 to 8192 cycles per second. Round figures may be substituted if this change is made in accepted commercial audiometers. Half octaves 1448, 2896, 5792, 9747 and 11,584 cycles per second may be included. The intensity scale should be in 10 decibel steps on the vertical axis covering the total range. Symbols for the right and the left ear should be printed on the form, *o* for the right ear, *x* for the left,

1. Thompson, E. A.: Methods for Recording Audiometric Findings Recommended by the Committee on the Conservation of Hearing, Tr. Am. Acad. Ophth. **51**:362 (March-April) 1947.

and space allowed to indicate the make and model of the audiometer used. When masking is used for air conduction, a triangle (Δ) for the right ear and a square (□) for the left ear are recommended. The intensity of the masking noise should also be clearly indicated. The corresponding bone conduction symbols recommended are a half triangle to the right of the vertical line for the right ear and a half triangle to the left of the vertical line for the left ear. The intensity of the masking noise for the bone conduction tests should also be indicated. When repeated audiometric tests are made, the numerical form of recording is recommended because it makes comparisons easier and conserves recording space. For publication, the audiometric chart is recommended for a single test or for one preoperative and one postoperative test, and the numerical or a composite audiogram should be used for a series of tests. For the publication of experimental research work, the committee agrees that the method of recording data should be left to the discretion of the author.

Fowler [2] describes his method of measuring the binaural percentage loss of capacity to hear the frequencies the hearing of which is most useful in understanding speech. Both ears are tested by standard audiometric methods, and the frequencies are weighted according to their relative importance for hearing and understanding speech, so that a weighted decibel loss is recorded for each ear. A table was constructed so that if a vertical line is drawn from the figure indicating the weighted decibel loss in the better ear and a horizontal line is drawn from the figure indicating the weighted decibel loss in the poorer ear, the point of intersection of these lines indicates the over-all percentage loss of capacity. This table enables one to allow not only for the changing increments of loss with different degrees of deafness in both ears but also for the changing ratio of importance of the hearing in the better and poorer ears with differences in binaural threshold tests. This method also takes into consideration the recruitment phenomenon. Figures printed at the side of the table indicate the subtractions and additions that should be made for this factor. The Committee on Hearing Aids and Audiometers of the American Medical Association did not accept this method but did adopt Fowler's figures for weighting the different frequencies for speech. However, this percentage hearing chart does not allow for the recruitment phenomenon and therefore loses much of its accuracy when one is calculating the loss of capacity in nerve deafness. To overcome this difficulty Fowler suggests that otologists use the figures 1 and 10 to multiply the present loss in the better and the poorer ear, respectively, if the better ear does not show

2. Fowler, E. P.: The Percentage of Capacity to Hear Speech and Related Disabilities, Laryngoscope **57**:103 (Feb.) 1947.

more than a 10 per cent loss of hearing. For losses in the better ear of more than 10 per cent, the ratio is varied by multiplying the percentage loss of the worse ear by the figure representing one-tenth the loss of the better ear. Illustrations are given to show how much better this method corresponds with the facts than the method adopted by the American Medical Association. The degrees of disability must be determined in the courts, the percentage of hearing capacity being used as a basis for calculation. The ability to overcome a handicap is often of greater importance than the handicap itself.

Hudgins and associates [3] describe two tests of hearing for speech the results of which can be measured in decibels, similar to that used to determine the loss of hearing for pure tones. The essential requirements are adequate test materials, suitable equipment and an established normal threshold based on the thresholds of a group of listeners known to have normal hearing. The tests measure the loss of hearing for speech by comparing the thresholds of hearing of the persons who have impaired hearing with an average threshold obtained from persons whose hearing is normal. One test employs words; the other, short sentences. The testing material to be used must employ a familiar language and words, with phonetic dissimilarity, comprising a normal representation of English speech sounds with the audibility of words or sentences understood with relative ease when they are spoken at a constant level by a normal talker.

The Western Electric audiometer model 4 C, which is used for group screening tests, has many merits. It is simple to operate, tests large groups at a time, requires no special sound-treated environment and is easily "scored" by using prepared forms and a scoring stencil. Its limitations, however, are that it covers only a limited range, it is not a precision instrument and limits itself to a 33 decibel loss, so that it is essentially a coarse screening device.

The program undertaken by the authors at the Psycho-Acoustic Laboratory, Harvard University, was to investigate further the problems involved in the construction of audiometric tests for measuring directly loss of hearing for speech, to produce a test suitable for precise laboratory measurements of all degrees of loss and to try to differentiate by means of verbal tests between high frequency deafness and a loss uniform throughout the audible frequency range. Although a high tone frequency test was devised, it offered no real advantage over the pure tone audiometer as a means by which to differentiate the several types of deafness. Two tests were devised to satisfy the need for a precise verbal instru-

3. Hudgins, C. V.; Hawkins, J. E.; Karlin, J. E., and Stevens, S. S.: The Development of Recorded Auditory Tests for Measuring Hearing Loss for Speech, Laryngoscope **57**:57 (Jan.) 1947.

ment by which to assess losses of hearing: auditory test 9 for the threshold of hearing for words and auditory test 12 for the threshold of hearing for sentences. Test 9 consists of two lists of 42 dissyllabic words of the spondee stress pattern as "blackbird," "railroad," in which both syllables are equally accented. Test 12 consists of eight lists of short simple questions, each of which can be answered with a single word. Each word and sentence is recorded at an intensity 4 decibels lower than the preceding one, yielding a total range of 24 decibels. Tests with various groups revealed that a single administration of test 9 to a normal or a hard of hearing subject will give a score that falls within 2.8 decibels of the subject's true score on that form of the test two thirds of the time. Similar comparisons show that a single use of test 12 will give a score that falls within 2.8 decibels of the true score of that form of the test two thirds of the time. A complete description of the equipment, how it should be set up, the details of the test, the lists of the testing material, the method of carrying out the test and the proper scoring are given in the article. This paper should be read to understand fully these carefully worked out tests for the accurate measurement of losses of hearing for speech.

Falconer and Davis [4] studied the reliability with which the normally hearing or the hard of hearing person can select his own threshold of intelligibility when a recorded sample of actual everyday connected discourse is used as the testing material. A test of this sort simulates everyday listening. The test is more interesting to the listener because he himself determines his own threshold of hearing. The electroacoustic apparatus employed consists of a turntable, an electrical pickup, an amplifier, a monitoring meter, an attenuator under control of the operator, a second attenuator under control of the listener and a receiver with rubber cushion held against the listener's ear by a suitable headband. The listener sat in a quiet, sound-treated room; the observer and the turntable, amplifier, etc., were in an adjacent control room. The sample of connected discourse was a newscast of Fulton Lewis Jr., special recordings of which were made by the Technisonic Recording Laboratories at the Central Institute for the Deaf. The person being tested had an attenuator box on his lap and was given a card with instructions as to how the test was to be performed. He was told to turn the dial to a point where he heard the best. The test was repeated three times. The dial reading for each sitting was recorded and the time recorded for each sitting was measured in seconds and recorded. Fifty normal and 94 hard of hearing ears were tested. A threshold setting was obtained usually in about twenty seconds. The total time

4. Falconer, G. A., and Davis, H.: The Intelligibility of Connected Discourse as a Test for the "Threshold for Speech," Laryngoscope **57**:581 (Sept.) 1947.

required for the three settings averaged about two minutes. Comparative tests made with test 9, employing the dissyllabic words described elsewhere in this review, gave almost identical results. The normal and the hard of hearing were about equally reliable with a slight advantage in favor of the hard of hearing. The advantages of this test are that it can be performed with speed, it has a greater interest for the listener and a lack of fatigue, it has satisfactory reliability with negligible learning effects and a high face validity in that a sample of an actual radio broadcast is used.

Trowbridge[5] made comparative studies of the commonly used hearing tests, namely, the whispered voice, pure tones of the audiometer and the tuning fork vibrations, and found that one cannot draw precise conclusions as to the efficiency of hearing from these methods as they are usually employed. This analysis was made on the basis of examinations made of 27,740 patients, 1,184 of whom were tested with the audiometer. The three methods of testing were carried out under the same conditions. The whispered voice test was performed by one trained medical technician. A detailed analysis of 300 unselected cases of defective hearing is presented in which comparative studies were made of the results obtained with whispered voice and audiometer frequencies. In only 2 cases of this group was a true low tone impairment of hearing found. On the other hand, 54 per cent were of the high tone type, and in 53 per cent of these cases the whispered voice test and the audiographic percentage loss in the conversational range revealed no loss of hearing. In 52 per cent of these cases there was also a complaint of tinnitus. The tuning fork tests were performed in many of the cases. In those cases in which bilateral hearing was considered normal by the whispered voice test, the Weber test was of special aid. Lateralization of sound proved to be an efficient and practical method of discovering a hearing deficiency in this group. The tuning fork results as a whole were inconsistent, and precise conclusions could not be drawn from them alone. There was not always consistent correlation between them and audiometric determinations. The author emphasizes the importance of detecting incipient changes in hearing, especially in hearing of the high tones, which can be done satisfactorily only with electroaudiography. The good hearing required in warfare and industry must be able to cope with an environment of noise and vibration. Normal hearing does not necessarily indicate a normal and stable hearing mechanism. The hearing function should be tested as to the rate and effect of fatigue, the threshold of the excitation of tinnitus and the presence of discrete high tone defects. Pure tone

5. Trowbridge, B. C.: Correlations of Hearing Tests, Arch. Otolaryng. **45**:319 (March) 1947.

audiometry should supplement the whispered voice test as a regulation test for the hearing of those entering military service. Controlled articulation tests against a background of measured noise should give additional evaluation of hearing acuity and efficiency.

The Council on Physical Medicine [6] has issued a new card readjusting the previous method of calculating the percentage of hearing loss, based on threshold measurements of acuity of hearing for air-conducted sounds. Just above the horizontal line designating the decibel loss, at each frequency (vertical lines) from 512 to 4096, inclusive, is a figure representing the weight percentage value of that frequency. The total percentage loss of hearing is arrived at by adding these figures for each ear, multiplying the loss in the good ear by 7 and that in the poor ear by 1, adding these products and dividing the sum by 8. This card carries clear directions for use.

The weighting of the percentage losses for the two ears represents the composite judgment of the consultants on audiometers and hearing aids. The major part of the work is credited to Drs. E. P. Fowler and Paul E. Sabine.

Silverman [7] studied tolerance for pure tones and speech on 46 normal and 46 hard of hearing ears, the latter representing a fairly balanced distribution of clinical types of deafness. Approximately 16,000 observations were made. Other studies have shown the inadequacy of the threshold audiogram alone to measure the impairment of auditory function. The impairment of understanding of speech also is more closely related to the over-all loudness loss at the intensity level at which speech is heard than to the threshold audiogram. A measuring of the threshold of acuity therefore cannot accurately predict how the impaired ear will function in an above threshold acoustic environment. For these reasons this study was made of the quantitative and qualitative nature of the tolerance limits for speech and pure tones of normal and deaf human ears. The objectives were to obtain data pertinent to the design characteristics of future hearing aids and to provide information which could guide procedure in the clinical selection of hearing aids. Three clearly distinguishable thresholds were found, namely, the discomfort threshold, where the stimulus became uncomfortable; the tickle threshold, where a definite tickling sensation occurred in the ear, and the pain threshold, where a definite sensation of sharp pain was experienced in the ear. The frequencies tested were 250, 500, 1000, 1400, 2000, 2800, 4000 and 5600 cycles per second. The subject was exposed to each

6. Tentative Standard Procedure for Evaluating the Percentage Loss of Hearing in Medicolegal Cases, Report of the Council on Physical Medicine, J. A. M. A. **133**:396 (Feb. 8) 1947.

7. Silverman, S. R.: Tolerance for Pure Tones and Speech in Normal and Defective Hearing, Ann. Otol., Rhin. & Laryng. **56**:658 (Sept.) 1947.

frequency for 1.5 seconds, starting at a level of 100 decibels, and the intensity was increased in 2 decibel steps without interrupting the tone up to 130 decibels. If tolerance was not reached at this point, the steps were then reduced to 1 decibel. Recorded monitored speech was introduced in a similar manner.

Silverman found that the initial pure tone thresholds for pain and for tickle lie at about 140 and 133 decibels above 0.0002 dynes, respectively, for all frequencies from 250 to 5600. The median thresholds are higher for the normal than for the hard of hearing group, the more sensitive hard of hearing persons reporting tickle and sometimes pain between 120 and 130 decibels. The contour of the discomfort threshold approximates that of the equal loudness contour with a broad minimum between 1400 and 4000 cycles per second. The initial median threshold for the normal (110 decibels) lies below the threshold for the hard of hearing (118 decibels). However, there is a great dispersion, especially among the hard of hearing. The shape of the discomfort contour is supported by the results obtained by Wegel, Lurie, Reger and others, and it strongly suggests that it is a high intensity equal loudness contour. Nothing was found to support the theory that high-pitched tones are more painful as suggested by Fletcher's results. The results obtained with speech were similar to those with pure tones. The tickle sensation is more constant for speech than for pure tones, and has a lower threshold, but pure tones cause more discomfort at lower intensities in normal ears than does speech. The thresholds of discomfort for tickle and pain rise systematically and significantly with successive test sessions, either daily or weekly, and approach limiting values after several test sessions. These values are largely retained after an interval of a week. More than half of the increase was retained for at least twenty-six weeks in the normal group and thirty-two weeks in the hard of hearing group. Increased tolerance developed in one ear does not increase the tolerance of the other ear of the same person. In the normal group, speech is as effective as pure tones in elevating tolerance for pure tones, but pure tone tests are only one-third as effective as the original speech tests in elevating tolerance thresholds for speech. A reverse relationship exists for the hard of hearing. Tolerance may be developed effectively by exposing the ear to loud speech at a level just below the threshold of discomfort for several minutes a day at three or four weekly intervals. Elevation of the tolerance produces at most only a small transient rise in the threshold of acuity. Results of this study indicate that 130 decibels seems to be the greatest useful maximum output of a hearing aid. Progressive elevation of tolerance with exposure to high intensity stimuli suggests that in the clinical selection of hearing aids preliminary determinations should allow for an eventual rise in the tolerance threshold. Clinical practice should be directed toward elevating

the tolerance threshold. Some persons whom audiometric tests have shown to be "totally deaf" might be reached by auditory stimuli directed through properly designed apparatus. The exposures of these tests produced slightly uncomfortable reactions in some instances. These reactions were only temporary.

Fowler Jr.[8] shows the fallaciousness of the accepted method of testing with voice and whisper as employed by the Army, the Navy and the Veterans Administration. The main sources of the unreliability are the ambient noise of the testing room, the variable voices of the examiners, and the conduction and reflection of sound by the walls, the floor and the ceiling of the room. He also shows with the use of the decibel meter that the reflex of raising the spoken voice with distance is so great as to make the loudness of the spoken voice unpredictable. The audiometer, although known to be more accurate, has not been used because of limitation of equipment and personnel and because of lack of time. These objections are overcome by using the method of pure tone audiometry pioneered by the Bell Telephone Company at the World's Fair in 1939-1940. Each patient of a group has a high quality receiver adjusted to one of his ears. The receivers are matched as to output for each frequency and are connected in parallel. Pure tones of each pitch are delivered through the receiver in spurts of tone in decreasing intensities. The patient writes down the number of spurts of sound heard in the proper place on specially prepared charts. After several frequencies and intensities have been tested, the answers are compared with the correct numbers which are watermarked on the paper and can be seen by transillumination. The score of correct answers can be interpreted into decibel losses. The Submarine School in New London, Conn., adopted the method for use with a standard audiometer. The receivers are accurately matched within 5 decibels, and the corrected normal threshold for each frequency is then used. With 15 receivers, using 30 decibels as the highest grade of loudness presented and covering the range from 256 to 8192, the average is forty seconds per man; with 40 receivers it is less than fifteen seconds. An accurate record of the man's hearing is obtained and can be used for comparison with subsequent records. With the same apparatus sweep tests, as well as individual tests, can be used as the situation warrants. Pure tone group audiometry presents the same difficulty as individual audiometry when ambient noise is present. Unless the noise level of the room is below 30 decibels, one cannot pick up 10 decibel losses, as the receivers cut out only about 20 decibels of noise. However, this is still far better than testing with voice and whisper in a free field. Fowler recommends that this method

8. Fowler, E. P. Jr.: Discovery and Evaluation of Otic Cripples, Arch. Otolaryng. **45**:550 (May) 1947.

be used wherever large groups of school children, industrial workers or service personnel must be screened for their evaluation and protection. This not only will protect the persons in question but will yield a financial saving to the boards of education, industrial concerns and the Veterans Administration.

Reger [9] has devised an instrument which can be attached to 40 Western Electric ear phones with the model H. A. 1 interiors.

The tones used are 256, 512, 1024, 2048 and 4096 cycles per second. A warning light signal precedes the tone by four seconds. The purpose of the test is explained to the subjects beforehand. Specially devised scoring sheets are used by the subjects. Preliminary tests are now being made with Permoflux ear phones which are reliable through 8192 cycles.

For the past eighteen months Dix and Hallpike [10] have been faced with the problem of examining a number of young children, many under the age of 6 years, for the purpose of establishing the possible role of deafness as a cause of backwardness in talking. In some instances the diagnosis lay between deafness and mental backwardness; in no case had a quantitative assessment of the hearing been obtained. As it was necessary to establish without delay what kind of special education was needed, and in view of the fact that many children were brought from a distance, there was need for a test procedure which would insure an accurate measurement of the hearing capacity in the course of a single examination.

Both speech and pure tone tests as ordinarily performed are difficult to apply to children under the age of 6. The former cannot be expressed in quantitative terms, and the latter are meaningless to a child of this age. With children who have defective hearing pure tone tests are even more unsatisfactory, owing to the extreme difficulty of explaining the nature of listening and of hearing. Nevertheless, the advantage of the pure tone audiogram makes it essential for the examination of the defective child. This is due to certain fundamental facts bearing on the relationship of pure tones to the hearing of speech. These relationships are expressed by the authors in a diagram of the normal intensity of ordinary speech in terms of decibels; the most important portion lying between 1000 and 2000 cycles per second is some 60 decibels above threshold in normal conversation at 3 feet (about 1 meter). Inasmuch as the ready understanding of speech sounds calls for an intensity of at least 20 decibels greater than that at which they can barely be heard, it is evident that a 40 decibel loss of hearing in the central area would

9. Reger, S. N., and Hays, A. N.: A Group Pure Tone Hearing Test, J. Speech Disorders **12**:61 (March) 1947.

10. Dix, M. R., and Hallpike, C. S.: The Peep Show: A New Technique for Pure-Tone Audiometry in Young Children, Brit. M. J. **2**:719 (Nov. 8) 1947.

give rise to difficulty in understanding conversation and a 60 decibel loss would mean total deafness.

In order to solve their problem the authors constructed an apparatus for obtaining pure tone audiograms, using the principle of the Pavlov conditioned reflex. There are two parts, a wooden box at the back of which is a picture suitable for children, and another part, screened from the first, consisting of a pure tone generator which is connected with a transformer in such a manner that when a switch is pulled, sound from a loud speaker and light from a signal bulb (both in the subject's box) are simultaneously emitted. When the child presses another switch near his box another light illuminates the picture at the back of the box. At first this maneuver is performed by an assistant seated near the child; in this way the child is taught that a picture view may be obtained during a synchronized light and sound combination. Later the signal bulb is eliminated and sound alone serves to inform him when to illuminate the box; the test then becomes strictly a test of hearing. The picture is changed for each frequency and the procedure repeated for all frequencies from 4096 to 256. The authors state that the test is generally completed in ten to fifteen minutes. Thirty-one children were examined in this manner. Explanatory diagrams and representative case histories are included.

Froeschels and Beebe [11] employed the Urbantschitch Whistles to obtain information as to the acoustic reaction of newborn infants in the first few days of life. Tuning forks were used in 10 cases as a means of control. Thirty-three babies between the ages of one-half to nine days were tested. Only three or four whistles were used in each case but different whistles were used with different groups so as to include the entire range. The acoustopalpebral reflex (blinking) is the most frequent reaction, whereas jerking movements and shrinking or turning toward the source are less frequent. Thirty-one of the 33 infants reacted positively to the whistles. No reactions were obtained with the tuning forks. The whistles test proved the presence of hearing in the great majority of newborn infants. The lack of response to the tuning forks is possibly due to the weaker sound employed and possibly the fact that different accoustic centers are stimulated by the compound tones of the whistles than by the pure tones of the tuning forks. The test is simple and does not harm the infant. It can be repeated at regular intervals if necessary, to determine early hearing impairments.

Arnold [12] recommends that various sources of sound of many intensities and tone qualities be in various positions in the room, controlled by

11. Froeschels, E., and Beebe, H.: Testing the Hearing of Newborn Infants, Arch. Otolaryng. **44**:710 (Dec.) 1946.

12. Arnold, G.: Electrical Devices for Testing the Hearing Reflexes, Wien. med. Wchnschr. **97**:32 (Jan. 11) 1947.

a central switch station. Automobile horns, door bells of various pitches and intensities, etc., are controlled by the examiner, who watches for the involuntary reflexes and other evidences of hearing. Since children are ignorant of the fact that they are being tested, they act naturally. A more detailed description is to follow.

Wishart,[13] discussing prognosis in the case of the hard of hearing child, states that the otologist should approach the child in a proper frame of mind and have the means and the environment for proper testing, and should repeat tests several times before a final opinion is expressed. The hearing impairment of the child should not be considered as having reached the stage of irreversibility until all investigative efforts have been utilized to establish whether or not it has. Although the pure tone audiometer measures the threshold hearing for pure tones, it still does not determine how well a person hears speech. There is no standardized quick simple method for the measurement of the hearing of speech. Although the 4 A audiometer, which in its present form is known as the 4 C, has its limitations, Wishart believes that it is adequate for testing the hearing of children for speech until new apparatus is devised. Two relatively new phonographic recordings have been developed at the Psycho-Acoustic Laboratory, Harvard University. They may be obtained from Central Institute for the Deaf in St. Louis. The words used are selected spondees, dissyllabic words with equal emphasis on both syllables. They are divided into seven groups of six words each, with each group recorded at progressively lower intensity levels 4 decibels apart. The range of levels is 24 decibels. The words are recorded at six second intervals. Each list is recorded as six scrambled versions, making 12 equivalent forms of the test. Amplification must be used for testing hearing losses greater than 24 decibels.

For the proper testing of hearing of children, Wishart recommends as equipment an approved pure tone audiometer and a phonograph audiometer with two recordings, the Western Electric two digit record K. S. 10087 and one of the Harvard records mentioned in the foregoing paragraph. The test should be made in a quiet room, with the sounds transmitted to the patient through ear phones. One ear is tested at a time, both ears being covered, however, with each ear phone having a snugly fitted cushion. When the pure tone audiometer test is done, the patient should sit with his back to the examiner. The test should be repeated at least once within a short period. This gives a method for comparison and determination of whether the patient's hearing varies or not. Once a variation is demonstrated, the otologist

13. Wishart, D. E. S.: Prognosis in the Hard-of-Hearing Child, Laryngoscope **57**:444 (July) 1947.

must make a continued search for factors which reasonably might cause these changes. The tests themselves rarely make a diagnosis as to the location and the type of the impairment. Wishart claims that the testing should not be entrusted to a trained technician. The tests are still full of the hazards of error, and a technician cannot have the important requisite of a proper understanding of his patient unless he is experienced in the practice of otology. He concludes by stating:

> . . . Hopeless prognosis for the little hard-of-hearing child must never be given unless the examiner has the ability to examine, has the proper apparatus and environment for testing the hearing, has the ability to apply the indicated therapy and, finally, has the patience and fortitude to do these things himself.

Michels and Randt [14] present an objective method of utilizing the galvanic skin response in differentiating organic from psychogenic deafness. A Grass Model 11 electroencephalograph was used for recording the galvanic skin reaction. The electrodes were applied to the skin of the palm and forearm. A standard audiometer (Maico Model D-5) was used as a source of controlled sound. The response consisted of a slow high voltage diphasic wave. The latent period was from one to three seconds between the stimulus and the response. The test, when properly performed, was found to be conclusive and especially suitable for testing total unilateral or binaural deafness in psychotic, retarded or compensation-minded patients. Several cases with graphic records are presented. This test is also applicable to other sensory disturbances, as blindness.

Semenov [15] speaks of deafness of psychic origin in an excellently conceived article that should be read in its entirety. He presents his material, consisting of 20 cases of malingering and simulation and 81 cases of psychogenic deafness, using as controls 22 cases of organic deafness. He carefully outlines the differential diagnosis between hysteria, psychogenic deafness, malingering and organic deafness with psychogenic overlay (conduction or perception type) and describes the technic of narcosynthesis, using pentothal sodium.® Incidentally, he mentions that the Russians use ether during the excitement stage for this purpose and one of the discussers uses sodium amytal.® He is insistent that the diagnosis should be made by an otologist, but the treatment may be administered by a psychiatrist. In the ensuing discussion Dr. Hoople relates that since he has learned of this condition he has been able to make two diagnoses thereof; Dr. Truex emphasizes the need to develop insight, to establish for the patient an understanding of his condition, in order to prevent relapses or conversion

14. Michels, M. W., and Randt, C. T.: Galvanic Skin Response in the Differential Diagnosis of Deafness, Arch. Otolaryng. **45**:302 (March) 1947.

15. Semenov, H.: Deafness of Psychic Origin and Its Responses to Narcosynthesis, Tr. Am. Acad. Ophth. **51**:326 (March-April) 1947.

of symptoms to other organs; Dr. Post mentions pseudovertigo and otalgia as occurring under like conditions, but thinks that removal of the psychiatric causative condition is all that is necessary.

Among the important diagnostic features of psychogenic deafness are: a history of trauma or emotional shock; a sudden and severe deafness out of proportion to the pathologic alterations, if any; audiometric thresholds that are flat or inconstant at several examinations and inconsistent with other tests; sudden improvement. The malingerer is always on guard against discovery; the patient whose deafness is psychogenic believes himself deaf and does not try to cover up. Hysterical deafness, which the author differentiates, is recognized by other hysterical manifestations, and encephalopathy, by other evidence of involvement of the brain.

Popa [16] states that otology offers three means of examining hearing: voice, constant noises, such as the ticking of a watch, and pure tones originating from tuning forks, monochord or audiometer. The common characteristic of these methods is that the source of the sound is outside the patient. A simple physiologic phenomenon observed by the writer leads to the announcement of a fourth means, a sound which originates within the patient.

Ordinarily when hearing is normal and the nasal passages open, tranquil respiration is not heard by the person who is doing the breathing; if it is perceived subjectively, it is perceived only because the sound of the air current issuing from the nose is being propagated toward the ears. If, however, one obstructs the ears lightly with fingers or makes light pressure on the tragi, nasal respiration is always perceived. Moreover, the character of the noise is modified; if it is increased, the resonance resembles that of a tube and, most important, one has the sensation that it is coming from the nasopharynx and not externally by air conduction. The sensation is analagous to the autophony noted in catarrhal conditions of the ear and for this reason the phenomenon has been named "autospirophony."

Autospirophony exists even if respiration is done with the mouth open or if only one nasal fossa is used. If only one external auditory canal is obstructed, the respiratory noise will be perceived by the obstructed ear alone. This bears an analogy to the Weber test as performed with tuning forks. Finally, if the pressure on the external auditory canals is greatly increased, the sensation disappears or, if the nasal respiration is very strong, it is again perceived by air conduction externally. This resembles the Gellé test for stapes fixation in which pressure is exerted on the stapes by means of the Politzer bag with

16. Popa, N.: A New Method for Testing Hearing: Autospirophony, Bull. Acad. méd. Roumanie **10**:7, 1945.

an olive tip in the external auditory canal while a vibrating tuning fork is placed on the skull. Popa believes that with the external canals lightly occluded the respiratory sound reaches the ear by bone conduction and that the test can be used to determine (1) whether the labyrinth is functioning and (2) whether there is ankylosis of the stapes. The test will have great advantages from a practical standpoint, and the author promises to make further studies in various aural conditions and to report his findings at a later date.

In an article contributed from the Corbino Electroacustic Institute in Rome, Lasagna and Nuovo [17] state that whereas the older otologists —for instance, Gradenigo—believed that paracusis willisiana was a true occurrence which was favored by rigid transmission mechanics such as are present in otosclerosis, the more modern writers feel that the phenomenon is only an apparent one, being generally due to the fact that speakers raise their voices in noisy surroundings.

The authors conducted careful experiments on several otosclerotic patients with paracusis willisiana, using words and nonsense syllables, presented by voice, phonograph records and loud speaker, as well as tuning forks, electric tone producers (a type of audiometer), masking tones and noises. Their conclusions were:

1. Paracusis willisiana could be demonstrated as a true phenomenon of otosclerosis by the use of the voice, with pure tones or noises being employed as a masking sound.

2. It could not be demonstrated when audiometers, phonograph records or loud speakers were used.

3. The factors involved in the production of paracusis willisiana are: (*a*) the failure of masking to take place; (*b*) the reflex effect of the tympanic muscles, whose activity is apparently increased by certain sounds; (*c*) the increase in labyrinthine pressure and stimulation of the organ of Corti exerted by a masking tone.

Porta [18] made tests with three tones, c-128, c-512 and c-2048, after the ear had been at rest and also after the ear had been stimulated for a given period of time with the same tone, allowing ten to fifteen minutes to elapse after the stimulation. He found that in normal hearing and in conduction deafness the rise of the threshold following the stimulation was between 5 and 8 decibels. In perception deafness, however, the rise was much greater, sometimes more than 20 decibels. It is suggested that this test may be of value in differentiating between perception and conduction deafness.

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17. Lasagna, F., and Nuovo, V.: Paracusis Willisii, Arch. ital. di otol. **54**:2 (Jan.) 1942.

18. Porta, C. F.: Audiometry: A New Method of Testing in the Diagnosis of Cochlear Disorders, Arch. ital. di otol. **54**:29 (Jan.) 1942.

Carrell and Gormley [19] conclude that the studies of Beasley have provided accurate measurements for the average threshold values of air conduction as incorporated in all acceptable audiometers. The majority of writers are agreed on the clinical usefulness of these measurements. The preponderance of evidence is that ability to hear speech can be predicted therefrom. Bone conduction measurements have perhaps a low degree of validity and reliability as to the recruitment phenomenon of Fowler. It is important in the audiometric examination of inner ear deafness. The studies of Steinberg and Gardner, however, tend to show that in unilateral nerve impairment ears may respond much alike at equal distances above threshold. Air conduction curves are correct within 5 decibels. Centuria and Thea and others find bone conduction curves much less reliable. Currier demands soundproof rooms as essential for reliability.

Almost no literature on the technic of audiometry is available. The direction of approach and the attitude of the operator are significant variables. A standard method should be formulated. The possibility of a valid and reliable method for testing hearing with speech needs exploration, and the phenomenon of recruitment should be given thorough experimental study and statistical analysis.

Mackenzie [20] reviews the established methods of diagnosis, hearing for speech, tuning forks and audiometer, and treatment according to the findings, by inflation, irradiation, fitting of hearing aids or fenestration, giving an excellent over-all view for the nonspecialist and even perhaps orienting the perspective of the specialist.

Lempert, Wever and Lawrence [21] present a preliminary report of the progress they are making in developing a practical and safe means for obtaining cochleograms, so that hearing defects can be studied and diagnosed objectively without the patient's influence. Previous work done on animals has revealed that the organ of Corti with its hair cells is the source of electrical potentials. Other experiments have revealed similar responses from man. The operation for tinnitus using the tympanosympathectomy technic permitted the development of such a test on essentially normal-hearing ears, from which a normal cochleogram could be obtained. A steel-lined room was constructed for the experiment, and special equipment was used. The electrode was inserted in the round window niche, probably in contact with the membrane. This area yields the largest potentials. Eleven ears were

19. Carrell, J., and Gormley, G. J.: A Critical Review of the Literature on the Validity and Reliability of the Audiogram, Speech Monogr. **13**:665, 1946.

20. Mackenzie, W.: Diagnosis and Treatment of Chronic Deafness, Post-Grad. M. J. **23**:3 (Jan.) 1947.

21. Lempert, J.; Wever, E. G., and Lawrence, M.: The Cochleogram and Its Clinical Application: Preliminary Report, Arch. Otolaryng. **45**:61 (Jan.) 1947.

tested in the course of operations for otosclerosis, tinnitus and Ménière's disease. Positive responses were observed coming from 4 ears and faint responses from 2 others. The remaining ears yielded negative results, probably because of failure of the electrode to make contact with the round window membrane. When the electrode was placed at the edge of the niche, on the promontory or at the newly created fenestra, the results were unsatisfactory. Making contact with the round window membrane is difficult, because the operative exposure permits only limited access to the niche and the membrane lies deep in its recess, out of view and at a difficult angle. Lempert and his workers hope to develop a method whereby the electrode can be placed accurately in contact with the round window membrane. If this can be attained, the pattern of activity of the normal cochlea and its variations will be obtained, and practical applications of this method will follow.

Von Békésy [22] believes in view of the sound pressure difference between the round and the oval window and the artificial window of the fenestration operation that a larger resonance chamber for the fenestra would be of benefit for increased hearing.

Rasmussen [23] studied the effect of various pressures produced in the external auditory canal on hearing through air conduction. A Dishoeck pneumophone was used. The source of sound was an air audiometer from which the tone was conducted to an amplifier in a soundproof box.

With lower frequencies the intensity of the sound was decreased by either overpressure or underpressure. With middle frequencies the findings were uncertain. At 8,200 and at 11,600 cycles per second the intensity of the tone was increased at pressures of 30 to 50 cm. of water. The explanations are discussed.

Metz [24] studied the acoustic physics of both normal and pathologic ears. His review of the literature included: the measurement of impedance by electroacoustic methods and by the measuring bridge; the technic of examination; sources of error; measurements of impedance on normal and on pathologic ears, including those with impaired hearing and normal drum membranes, both conduction and perception types. Ménière's

22. von Békésy, G.: Sound Pressure Difference Between Round and Oval Windows and Artificial Window of Labyrinthine Fenestration, Acta oto-laryng. **35**:301, 1947.

23. Rasmussen, H.: Studies on the Effect Upon the Hearing Through Air Conduction Brought About by Variations of This Pressure in the Auditory Meatus, Acta oto-laryng. **34**:415, 1946.

24. Metz, O.: Acoustic Impedance Measured on Normal and Pathological Ears: Orientating Studies on the Applicability of Impedence Measurement in Otological Diagnosis, Acta oto-laryng., 1946, supp. 63, p. 3.

syndrome and 2 cases each of paresis of the trigeminus nerve and 2 of paresis of the facial nerve are described. The article should be studied in its entirety.

Lindsay [25] analyzes his fenestration results from the standpoint of preoperative and postoperative tests in an attempt to establish criteria for evaluating the possibilities for improvement in patients to be operated on. A relatively simple speech test consisting of a series of 60 monosyllabic words divided into low, medium and high-pitched groups was made in a sound-treated room, and the results were compared with pure tone thresholds for air and bone conduction. This was done before and after operation to find out to what extent such tests may be utilized in the estimation of the possibilities for improvement of hearing. He found a close correlation with the air conduction thresholds from 512 to 2048. Speech perception was found to depend mainly on the 2048 frequency. The low frequencies were of progressively less importance. A threshold of 15 decibels or better in the 2048 and 4096 region is associated with good speech reception. A threshold of 15 decibels or better in the 2048 region alone enables the patient to understand speech well. When the pure tone threshold falls off above 1024, the decrease is reflected in the speech test for words of high pitch. A correlation of preoperative air and bone conduction thresholds with the postoperative air conduction threshold revealed the following facts: A dip occurring in the bone conduction threshold at 2048 with normal findings above and below consistently indicated a similar dip in the air curve at this frequency postoperatively, showing an inner ear deficiency at this level. Since hearing of 2048 is important for speech perception, a deficiency in cochlear function at that level is of prognostic significance. His series revealed that consistent finding of a depression of the bone conduction threshold was a reliable indication of a decreased possibility for improvement by fenestration. Lindsay mentions the difficulties of accurately estimating bone conduction. Great care and proper masking are always necessary. Repeated tests should be done when any abnormality is found in the speech range. Where considerable difference in hearing is present for air-conducted sound, the bone conduction results on the poorer ear are likely to be unreliable and may appear better than is actually the case. He questions whether masking can be reliably carried out for bone-conducted sounds. He also questions whether a hearing loss of 60 decibels by air conduction can occur without some degree of perceptive impairment. In his series of 34 consecutive cases after eight months 76.5 per cent showed a satisfactory hearing improve-

25. Lindsay, J. R.: The Fenestration Operation: Observations on the Evaluation of Hearing Tests, Laryngoscope **57**:367 (June) 1947.

ment based on an average 30 decibel threshold for the frequencies 500 to 2000. However, only two thirds of these cases were considered fully satisfactory.

ACOUSTIC TRAUMA

Nussdorfer [26] comments on the growing importance from the medical and social standpoints of occupational deafness, this being due to the continuous expansion of industry. He quotes such authorities as Voss (72 per cent of carpenters show professional deafness), Beck and Holtzman (60 per cent of their workers are more or less deaf), Sacher (only 21.6 of coppersmiths possess normal hearing) and others to show the effect of noisy occupations on the human ear.

Authorities vary as to the amount of noise which is harmful. Beck and Holtzman place this at 60 phons, but Peyser put it as low as 40 to 35 phons.

The question of the route by which the harmful sound is transmitted has occasioned a good deal of discussion. The older otologists —for instance, Siebenmann—maintained that this could occur only by the usual route for hearing. Wittmaack believed that the cochlea could be damaged through the mastoid process or by vibrations reaching the cochlea through the skeletal system. A great deal of experimental work by Langenbeck, Luscher, von Békésy and others on this subject as well as on the protective capacities of the ear is quoted by the author; the consensus favors air transmission as the important factor.

Nussdorfer was able to study two groups of patients: The first group consisted of workers who had spent from six months to three years at their occupation; the second, of workers who had been exposed to noise for several years. A subgroup comprised patients whose deafness had been caused by explosions. Persons suffering from hereditary deafness or other aural conditions not due to work were excluded.

In persons with the "apprentice type"—those whose hearing organ had been traumatized for six months to three years—as well as in those exposed to the more acute types of trauma, the most characteristic defect involved the region of 4096 with "transitional" curves intervening (i.e., leading to the classic type of deafness resulting from long exposures to acoustic trauma).

Fifty patients in the second group—those with long service—were studied, and all of them manifested in greater or lesser degree the classic perceptive lesion. The American type of audiogram, indicating both air and bone conduction, is used. The characteristic curve shows a small loss in the low tones with a gradual, continuous falling away from the normal range as the high tones are approached, the bone conduction

26. Nussdorfer, R.: Audiometry in Occupational Deafness, Oto-rino-laring. ital. **12**:431, 1942.

curve running parallel to the air conduction curve. The curve of the patients with more advanced injury shows some divergence between the air and the bone conduction curves in the low tones; in the patients with the worst injury bone-conducted sound is heard only at the pain threshold. The author stresses the importance of the work of Crowe, Guild and Polvogt in correlating audiograms of "gradual" and "acute" inner ear deafness with histologic pictures obtained by postmortem study of the same patients. As means of lessening the incidence of occupational deafness, he suggests that workers exposed to noise have periodic examinations and changes from noisy to quiet surroundings at intervals.

Grove [27] reviews early reports on the effect of noise on hearing and the various factors involved. Noises below 100 decibels of intensity can be disregarded as causative factors. Consideration must be given to the duration of exposure and to the health and the age of the worker. The chipping hammer leads the list of sources of irritating noise in industry. It produces from 110 to 135 decibels of noise. The noise is greater near the hammer than behind it. It is also greater in a confined space with sound-reflecting walls than in a free field. The riveter is exposed to a noise of 115 to 128 decibels, with the noise level greater on the other side of the plate where the rivet bucker is working with a small pneumatic hammer. The pneumatic hammer and the pneumatic drill are also sources of excessive noise.

Although the noise of industry cannot be eliminated, there are three ways to reduce it and protect the ear against its effect. First, the noise should be reduced at its source by redesigning machinery to reduce vibrations, proper planning of machines, reducing noise in part by substituting nonmetallic substances for metallic ones, proper suspending of machines, etc. Second, the source of noise should be properly enclosed and the spread of noise prevented by proper treatment of the surrounding walls and ceilings. Third, the ear itself should be protected by wearing proper ear plugs or defenders. For satisfactory evaluation of defects arising from such trauma, Grove makes a plea to otologists, industrial physicians, managers of industry and insurance carriers to see that accurate preemployment audiometric examinations of the hearing of every worker be made by qualified examiners under conditions that are relatively comparable.

Russi [28] has recorded the noise levels of a brazier's forge, a dye factory and a textile factory as determined by an acoustic expert, which range from 100 to 115 phons. In the initial stage the auditory damage is shown by a loss for 5000 cycles per second. Later this loss broadens

27. Grove, W. E.: Noise in Industry, Laryngoscope **57**:114 (Feb.) 1947.

28. Russi, U.: Acoustic Damage in Industry and Its Prevention, Pract. oto-rhino-laryng. **8**:71, 1946.

out and hearing is impaired first for the whispered voice, eventually for conversation. In the early stages some recovery for conversation occurs after a short respite from work.

The ear defender of Rüedi and Furrer (see later page) protects healthy ears if worn during work. Those whose hearing is improved by rest retain the improvement if protected.

MacLaren and Chaney [29] have considered some of the factors in deafness due to industrially produced noises: i.e., over-all noise level, time of exposure, the effect of preexisting conduction deafness and, briefly, the effect of ear protection and the rate of recovery.

Levels above 100 decibels are common; riveting is an important source of hazardous noise. Industrial noise is usually of the broad spectrum variety. Five thousand audiograms have been analyzed and classified.

The major portion of hearing loss due to noise takes place in a few days and at first involves frequencies above 2048. Later the loss extends to lower frequencies. After the patient has been removed from noise, recovery, if it takes place, is in reverse order.

Ear defenders that attenuate the higher frequencies enough to bring the all-over loudness below 100 decibels will allow a measure of recovery. When noise levels exceed 100 decibels, free employment audiograms should be obtained. Progressive deafness after six months should call for transfer to quieter surroundings.

Persons showing a flat loss of conduction hearing do not need to be excluded from noisy areas.

A noise hazard should be controlled at the source. No other method of control is perfectly effective.

Wishart [29a] describes a soundproof room for testing hearing in hospitals and doctors' offices which has been in use several years and has proved satisfactory. The audiometric testing is done accurately, quickly and simply. The methods and the conditions of testing can be repeated with exactitude.

One room is constructed inside another on top of a concrete floor slab floated on rubber above the previous floor. The final room is separated by an air space from the adjoining walls and ceiling, and the whole is lined with perforated transite. The new walls are heavily insulated. The doors close against the frame with a double rubber gasket to make the joints airtight. The doors are opened frequently, and a small fan expels the stale air.

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29. MacLaren, W. R., and Chaney, A. L.: An Evaluation of Some Factors in the Development of Occupational Deafness, Indust. Med. **16**:109 (March) 1947.

29a. Wishart, D. E. S.: Practical Methods of Testing Hearing for Hospital and Offices, Canad. M. A. J. **55**:567-571 (Dec.) 1946.

Escher [30] describes a circumscribed loss of hearing, usually about 4000 to 5000 cycles, after cranial trauma without fracture, accompanied in most cases with high-pitched tinnitus; the patient senses the blow as a loud sound. Sometimes this is accompanied with disturbances of equilibrium.

Rüedi and Furrer [31] distinguish four types of acoustic trauma, based on clinical investigation.

Functional and histologic reconstruction of noise and explosion trauma was done by animal experimentation, and head injuries in human subjects were studied. Fatal injuries in persons who had sustained trauma of the ears were followed up by histologic examinations, although these were made difficult by autolytic changes.

The authors explain the usual loss of hearing at 4000 to 5000 cycles as follows: The whorls in the endolymph set up by vibrations, either through concussion of the labyrinth or by the sound occasioned thereby, travel upward and downward from the cochlear area at 4000 cycles; this area thus sustains the greatest disturbance. Authors have designed an ear defender which is intended to protect the ear especially from sound frequencies in this area and which does not diminish perception of sounds in the speech range to the extent that other protectors do.

Some of the clinical assistants offered themselves for experimentation after preliminary hearing tests. With the subject under local anesthesia, an incision was made over the mastoid process and the bone laid bare; five strokes of a metal hammer were delivered. The subject experienced a loud noise with tinnitus at 3000 cycles. This disappeared in half an hour. Audiometric controls were made at fifteen minutes, ten hours, twenty-four hours and forty-eight hours. Both ears showed a localized loss of 22 decibels, which was better in twenty-four to seventy-two hours. In guinea pigs histologic examinations were made subsequent to both head trauma and exposure to calibrated noise over measured periods. The auricle reflex was used as an index of hearing at various frequencies and intensities. The cochleas were later examined histologically. The authors do not agree with Lurie's findings that the endothelial cells lining the scala tympani on the lower surface of the basilar membrane are the most vulnerable. They find numerous instances of no pathologic change in this region with destruction of some of the hair cells present.

The article covers 194 pages and is beautifully illustrated with color plates of drum membranes which had sustained explosion trauma and many black and white illustrations of histologic aspects, of instruments

30. Escher, F.: Cerebral Trauma and Hearing, Pract. oto-rhino-laryng. **8**:505, 1946.

31. Rüedi, L., and Furrer, W.: Acoustic Trauma, Pract. oto-rhino-laryng. **8**:177, 1946.

of precision used in measurements and other experiments, and of some of the experiments themselves.

Grove [32] reviewed a series of 832 cases of craniocerebral trauma with demonstrable signs of injury to study the associated impairment of hearing. This series included 15 cases of transverse fractures of the petrous pyramid, 25 cases of bilateral longitudinal fracture of the temporal bone and 92 cases of unilateral longtitudinal fracture of the temporal bone. His findings show that better than 25 per cent of the patients will show impairment of hearing; 81 per cent of these will exhibit either a pure perceptive or a mixed form of impairment. The probability of a loss of hearing increases with age, but one cannot say whether it will be unilateral or bilateral. An almost total loss of hearing can occur without any demonstrable evidence of bone fracture. This may be due to hemorrhage involving the cochlear spaces, with subsequent organization. His study also demonstrated that preexisting deafness can be aggravated in older persons and that traumatically produced defects of hearing are just as likely to remain stationary or to improve or to become more progressive.

Weiss [33] presents an analysis of 72 cases of deafness due to acoustic trauma. The degeneration of the various areas of the organ of Corti varies with the extent of the trauma, moderate damage being limited to the basal coil, corresponding to tones above 2048, severe trauma affecting the entire tone range. The changes may be transient, irreversible or even progressive. Moderate trauma produced the most constant effects, manifested in the audiometric curve by a V dip of varying degree with the decline centering at 4096 in 37.4 per cent of the cases, at 2896 in 11.3 per cent, and at 5792 in 7.3 per cent. There was an equal loss at 2896 and 4096 in 12.2 per cent of the cases. The hearing for 4096 cycles per second appeared to be the most vulnerable to trauma. Seventy-three curves (58 per cent) showed a secondary decline at 11,584 after recovery from the dips at 5792 and 8192. This can be considered an intermediate stage between the moderate and the severe loss of hearing. Various patterns were observed in the audiograms in the other cases. When the trauma was more severe, the V notch broadened to include the frequencies between 1024 and 8192. In still more severe trauma greater losses were disclosed, ranging to total deafness.

Tinnitus was the most common symptom in these cases. There was no constant relationship between the degree of deafness and the intensity or the persistence of the tinnitus. Only 31.9 per cent of the patients of this series had a ruptured tympanic membrane, with otitis media

32. Grove, W. E.: Hearing Impairment Due to Craniocerebral Trauma, Ann. Otol., Rhin. & Laryng. **56**:264 (June) 1947.

33. Weiss, J. A.: Deafness Due to Acoustic Trauma in Warfare, Ann. Otol., Rhin. & Laryng. **56**:175 (March) 1947.

occurring in only 8 cases, or 11.1 per cent. There was no parallelism between the deafness and the concomitant symptoms and findings. The degree of spontaneous recovery is unpredictable. Slight impairments may recover completely; moderate losses may show gradual improvement, but it should not be anticipated if it does not occur within two to eight weeks. In severe injury the initial loss is usually constant and permanent. In others the loss may be progressive over a period of months. The important phases of treatment are prevention and rehabilitation. The general use of ear plugs would have appreciably reduced the large number of cases of acoustic trauma. Education of all military personnel as to proper preventive measures and employment of these methods in industries where acoustic trauma may occur will in a large measure prevent this type of hearing impairment.

Cope and Johnson [34] found that about 8.9 per cent of the soldiers being examined because of complaints referable to ear, nose and throat in the separation center had a high tone deafness due to acoustic trauma of gunfire, shell fire and blasts. Many of them did not realize they had a loss of hearing but complained of inability to hear a watch tick, of tinnitus or of inability to hear the voices of women well. The tonal drop usually occurs from 2048 to 4096 cycles, with the maximum effect being reached at 4096. The most common type accompanied the firing of the Garand or M-1 rifle. The hearing is normal to 2046 and then drops 10 to 60 decibels lower at 4096, and then either rises or continues to fall. The second most common type was from the noise of rapid fire guns; there was a general drop of hearing in the ear nearer the gun but relatively unaffected hearing in the other ear. The audiogram of this type also showed the drop at 4096. The distance from the noise, as well as the repetition of the noise, climatic conditions and topography, the patient's condition and the amount of protection were all factors in the production of the acoustic scotoma. The preventive devices supplied by the Army were inadequate, as they did not enable the soldier to hear orders and were therefore discarded, with resultant trauma.

Hoople, Wolfe and Bregande [35] wanted to determine whether there was any evidence of cochlear injury in the battle-exposed soldier who did not complain of loss of hearing. Audiograms were made for 1,200 soldiers who had been in active combat but made no complaint of lowered hearing. These men were selected at random. A control series of 150 soldiers who had not been exposed to combat and had no subjective loss of hearing were examined. A composite audiogram of the 1,200 soldiers revealed some loss throughout the entire range, with the

34. Cope, B. A., and Johnson, H. B.: Aural Scotomas Produced by Gunfire, Arch. Otolaryng. **45**:676 (June) 1947.

35. Hoople, G. D.; Wolfe, W. C., and Bregande, S. C.: Unrecognized Battle Noise Trauma, Laryngoscope **57**:125 (Feb.) 1947.

characteristic high tone loss beginning at the 2896 level. Audiograms of soldiers who had localized the side of the explosion showed no correlation between the side of greater audiometric loss and the side on which, it was maintained, the explosion occurred. The records of 1,000 of the 1,200 soldiers were studied in detail. Of these, 210 were 30 years or older, and 790 were under 30. Twenty-one per cent of the whole group showed limitation of motion of either the drum or the malleus. A comparison made between those who were in the infantry and those who were in the armored divisions revealed a slightly greater audiometric loss in the infantry. Seventy per cent of the entire group had a loss of 30 decibels or more in one or more of the frequencies tested; 30 per cent of the control group which had not been in combat also showed such a loss. Approximately 40 per cent of the soldiers subjected to battle noise have a recordable degree of acoustic trauma. Unless the soldier had a previous audiogram, one could not definitely state that he was a victim of acoustic trauma resulting from battle noise, since 30 per cent of American soldiers had an appreciable degree of audiometric loss before they entered battle. Present induction examination methods are inadequate to determine the acuity of hearing of the men of the armed forces. This study reveals the fact that there must be a large group of undiscovered or unrecorded armed personnel with varying degrees of battle noise trauma. As a result, the seriousness or the extent of the problem of the acoustically handicapped of World War II will never be known.

Graebner [36] presents a survey of the audiometric findings of a group of 449 airline pilots of various ages and hours of service. All were pilots of D C 3 B transport planes. The survey creates the impression that there is a causal relationship between professional aviation and auditory deterioration. The hearing losses are greater than those in the average civilian population of comparable ages.

Taylor [37] describes the V-51R ear warden, which was the result of exhaustive research of outstanding scientists under the direction of the National Defense Research Committee of the Office of Scientific Research and Development. This device is comfortable and affords acoustic insulation of from 25 to 30 decibels at the low end and 40 decibels or more at the high end of the audiometric frequency spectrum. It was especially designed to protect against the noise and blast of heavy gunfire, being superior to cotton. It does not interfere with the comprehension of a command nor hinder seriously speech communication. This device was developed too late to be available in large quantities

36. Graebner, H.: Auditory Deterioration in Airline Pilots, J. Aviation Med. **18**:39 (Feb.) 1947.

37. Taylor, H. M.: Ear Defenders, Laryngoscope **57**:137 (Feb.) 1947.

during the war. It should be of great value in industry as well as in warfare. (The V-51 ear warden is manufactured for civilian use by the Mine Safety Appliance Company, of Pittsburgh.)

CONSERVATION AND REHABILITATION

Sullivan [38] and his associates developed special equipment and utilized known basic principles and tests for the testing of the Royal Canadian Air Force, to overcome existing deficiencies in evaluating hearing ability encountered in both World Wars. Specially constructed calibrated audiometers and commercially produced audio-oscillators were employed as sound sources. A mobile soundproof room was constructed for field surveys. With this unit men were tested at the commencement, during and at the completion of their flying training. Over 11,000 hearing tests were made at the flying stations. The survey disclosed that little if any hearing loss can be said to occur during flying training. Although the hearing is impaired for several hours after descent from flight, the impairment is not permanent. Articulation tests were used to provide supplementary data. The material used was the Harvard No. 9 Test with some modifications. A gramophone audiometer developed by the Royal Canadian Air Force was used, and the tests were conducted in a sound-treated room. A comparative test was made with the pure tone audiometer, using frequencies from 512 through 2048 cycles per second. A field survey was made of 250 men, of whom 191 were chosen at random. This comparative test showed a significant correlation of 0.69 between the pure tone test and the articulation test for 137 of the 191 men among whom there were only 29 abnormal ears. From the 59 selected men having 98 abnormal ears, a correlation of 0.85 was obtained for the same comparison. Another survey was made with 4,687 men, in which the whispered voice test and the audiometric test were compared. The 20 decibel level shown in the American Bell Telephone and the United States Bureau of Public Health audiometric surveys as being the upper limit of the zone of hearing for young adults was taken as the normal or passing mark. Of the total of 4,687 men, 4,198, or 90 per cent, passed both the whispered voice and the audiometric tests; 435, or 9 per cent, passed the whispered voice but not the audiometric test; 54, or 1 per cent, failed both tests. Of the 489 who failed the audiometric tests, 50 per cent gave a history of previous ear trouble, 69 per cent were normal on physical examination, and 31 per cent had positive otologic findings in the ear. The audiometer proved to be superior to the whispered voice for testing hearing and showed its practicability and durability under constant use. Sullivan subscribes to the general recommendations determined at a meeting of

38. Sullivan, J. A.: A Statistical Analysis of Audiometric Surveys in the Royal Canadian Air Force, Ann. Otol., Rhin. & Laryng. **55**:839 (Dec.) 1946.

the joint services at a conference of sound held in New London, Conn., in June 1945, namely, that joint specifications for audiometers, testing rooms and procedures should be written in as much detail as possible; also that service training schools for audiometrists should be established, and, finally, that audiometric criteria for specific service jobs could probably be set up in many cases.

Morrissett [39] reviews the history, the development and the procedure of the aural rehabilitation program of the United States Army. He was chief of the otolaryngology branch in the Surgical Consultants Division of the Surgeon General's Office and was directly responsible for the organization and development of this program. Details of the methods employed and the various tests used have been reported in our previous reviews. Approximately 8,400 deaf and hard of hearing soldiers were treated in the three centers during the three years of operation of these centers. An interesting observation was the relatively small number of permanent impairments of hearing resulting from blast injuries. Only about one third of the soldiers subjected to this trauma were left with permanent deficiency.

Psychogenic deafness was of combat origin in about 60 per cent of the cases. The experience gained from such a program should be utilized and applied to the problem of civilian hearing deficiencies. The program involves the integration of trained personnel, clinics, laboratories, electroacoustic equipment and classrooms under a single roof. An otologist should always be in charge of such a plan, as the problem of auditory impairment is primarily a medical one.

Work [40] outlines the hearing and rehabilitation program which was carried out at Borden General Hospital, Chickasha, Okla. Similar programs have been surveyed in this review during the past two years. Those not familiar with this program should read the article for complete details.

McIntire [41] reviews the rehabilitation program for the deaf as carried out by the Navy during the last war. Details of the program were reviewed in our last report. He suggests that the principles which have been employed in the Acoustic Clinic at Philadelphia be applied and developed in civilian clinics throughout the country. These clinics would provide a means of checking the residual hearing of the man with impaired hearing who must be cared for throughout his entire life.

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39. Morrissett, L. E.: The Aural Rehabilitation Program of the U. S. Army for the Deaf and Hard of Hearing, Ann. Otol., Rhin. & Laryng. **55**:821 (Dec.) 1946.

40. Work, W. P.: Aural Rehabilitation Army Experience, Laryngoscope **57**:423 (July) 1947.

41. McIntire, R. T.: Program for the Deaf, Mil. Surgeon **100**:207 (March) 1947.

A November 1946 bulletin of the Canadian Department of Veterans Affairs gives in detail the established auditory tests and instructions for the fitting of hearing aids, and requests for the fenestration operation, as practiced in the Canadian Veterans Affairs Department.[42]

Ewing[43] discusses the renewed interest taken in the problems of the deaf in England. Special committees have been appointed to survey these problems in order to promote and coordinate investigations for proper treatment of deafness and construction of hearing aids and pure tone and speech audiometers. The main objective is to deal with the permanent problem of defective hearing in children and civilian adults as well as in veterans. A new otological research unit was established at Manchester University. A small number of hearing aid clinics attached to hospitals in London and elsewhere are also in operation. At Manchester University children of school age are given pure tone audiometer and speech tests. Tests are designed to determine how well a child can hear in a normal quiet environment such as that encountered in ordinary conversation with parents, for example, and in a noisy environment, such as that encountered at school. A fundamental principle adopted by the Ministry of Education is that no child with defective hearing should be admitted to a special school for the deaf or hard of hearing if by educational treatment or with the use of a hearing aid he can continue to make good progress in an ordinary school. In order to determine this, tests of vocabulary and verbal comprehension, as well as tests of educational achievement and performance tests of intelligence are made.

Goodhill[44] stresses the great importance of very early education and training of the preschool deaf child as carried out at the John Tracey Clinic in Los Angeles. The testing of very young children should be based on known psychologic principles. In young infants the use of the eye reflex, as involuntary blinking, jerking of the eyeball or even pupillary dilation if the sound stimulus is potent enough, is the test usually employed. With children 2 years of age or over, varying intensities of whisper and spoken voice can be used; sources of sounds, such as bells and whistles, to cover the auditory range, can also be employed to give the examiner a rough audiogram. A frequency-modulated loud speaker as a source of sound can also be used to delineate further the potential frequency spectrum heard by the child. To discover residual islands of hearing is also important for future training when amplified sound can

42. Treatment Services Bulletin, Canadian Department of Veterans Affairs, November 1946, vol. 1, p. 15.

43. Ewing, A. W. G.: Hearing Aid Clinics in England, Laryngoscope **57**:41 (Jan.) 1947.

44. Goodhill, V.: The Educational Treatment of the Pre-School Deaf Child, Laryngoscope **57**:555 (Aug.) 1947.

be used to stimulate these remnants of hearing. When a child responds to no stimuli, the estimation of the vestibular function is important. Total absence of vestibular responses rules out usually the possibility of any islands of hearing. However, an active response does not necessarily indicate the presence of any hearing, but it does mean that the pathologic process of the cochlear apparatus is not a total one and that some hearing may be present. In cases of a congenital defect of the external auditory apparatus, roentgenography and the use of the Mayer position as modified by Dr. Gilbert Roy Owen will enable one to visualize the ossicular chain if it is present.

Preschool education means very early training, namely, at 2 to 3 years of age. The mother at home becomes the first preschool educational approach. Various courses of speech preparation, lip reading, sense training and guidance in the proper approach to the deaf child are offered the mothers at the John Tracey Clinic, which can be followed either at the clinic or as correspondence courses in those cases in which mothers have no access to proper nursery schools for their deaf children. During the past three years 87 mothers have received regular class instruction at the clinic. During the six week summer sessions 93 children and their mothers have been in attendance. Three hundred and sixty-two mothers throughout the United States, Canada, England, Australia and other countries are enrolled in the regular correspondence school. Over 800 mothers have now received all or part of the course. All this work is done without charge. At the end of three years or more of instruction these children are ready for the first grade of a school for the deaf. In comprehension of language they are superior to the deaf child who starts school at 6 years of age and continues for two years. In the two years between 3 and 5 more is accomplished than in the two years from 6 to 8 by the child starting at 6. The age of 3 to 6 is the most important one in the formative educational life of the deafened child. Preschool nurseries for the instruction of deaf children should be started throughout the country wherever possible in connection with established schools for the deaf or, if necessary, with ordinary grade schools. There is a need of special teachers for these children and some inducement should be created to entice intelligent teachers into this work. Physicians should initiate, encourage and supervise these programs. At home the deaf child should be treated normally and should be spoken to constantly. These two principles should be impressed on parents of deaf children.

Tamari and Speas [45] made a survey of the ear, nose and throat conditions of the children at the School for the Deaf at Jacksonville, Ill.,

45. Tamari, M., and Speas, R.: Ear, Nose and Throat Survey of Children in the School for the Deaf at Jacksonville, Illinois, Ann. Otol., Rhin. & Laryng. **56**:425 (June) 1947.

to determine etiologic factors, to classify the various types of deafness and to diagnose accurately the cases in order to determine properly therapy, prophylaxis and future vocational training. Of the 398 children examined, 172 were girls and 226 were boys. The deafness of 72 per cent of these was congenital in etiology; that of 11 per cent was due to meningitis and that of 15.8 per cent was due to other causes, the most important of which were chronic otitis, scarlet fever and measles, influenza, pneumonia and accidental and natal injuries. In general the audiograms and the findings with the tuning forks and the spoken voice were in agreement. Only 4 children were encountered who were able to hear the whispered voice in both ears at close range and 3 others who could hear the whispered voice in the left ear only. Nine per cent heard loud spoken voice at the ear bilaterally, 10 per cent in the right ear only and 11 per cent in the left ear only.

Nystagmus of all three degrees was elicited in 288 children, or 70.5 per cent. In the meningitis group 32.8 per cent presented normal vestibular reactions. Good usable speech was present in 82 children of the entire group.

The writers feel that a complete otological examination and an accurate diagnosis should be made on all children who are admitted to educational schools for the deaf. This is now being done at the Jacksonville school. Careful histories and an intensive study of the genetics of deafness should be made and followed through. Head noises and dizziness are two symptoms found in patients with acquired deafness that are not present in the congenitally deaf. The importance of the prevention and the reduction of infections of the upper respiratory tract of deaf children is stressed. Tonsillectomy and adenoidectomy should be performed and roentgen ray and radium therapy applied for excessive or residual lymphoid tissues on the lateral pharyngeal wall and in the tubal ostium in more of these children. Proper therapy should be employed for suppurative otitis media. An active otologic service should be established in all institutions for the deaf to diagnose and classify cases properly, to improve and preserve residual hearing and to aid in the educational program and in the utilization of the latest methods of therapy and training, as well as to insure proper vocational guidance.

Clayton-Jones [46] investigated the effect of rubella occurring during pregnancy as a cause of congenital deafness in England by sending questionnaires to mothers of children in three of the larger and one smaller school for deaf children. The association of maternal rubella occurring in the first three months of pregnancy and congenital defects such as cataract, deaf-mutism and cardiac lesions has been established

46. Clayton-Jones, E.: Rubella as a Cause of Congenital Deafness in England, Lancet **1**:56 (Jan. 11) 1947.

in Australia and confirmed in the United States. In one school of 18 children 8 mothers gave a definite and 1 a probable history of rubella occurring in the second to the fourth month of pregnancy. In the three larger schools a positive history of rubella occurring in the first four months of pregnancy was obtained from the mothers of 123 children. These deaf children have a bilateral, incomplete inner ear deafness, usually fairly uniform throughout the frequency range. There was usually an associated history of a difficulty noted in feeding during infancy, and examination showed a tendency toward deformity of the jaw with narrowing of the mandibular arch and a widely curved maxillary arch, resulting in crowding of the lower and wide spacing of the upper incisor teeth. Other findings were a pigeon chest and an atonic musculature. The writer suggests that an attempt be made to protect pregnant women against rubella in the first four months of pregnancy.

Hopkins [47] also suggests that rubella occurring early in pregnancy may be the cause of congenital deafness in certain cases that have formerly been unexplained. She reports 10 such cases. Two other cases in which the mother had another virus disease, such as influenza, and 6 other cases in which no virus disease was present during pregnancy are reported in which some of the same congenital defects were exhibited.

Ry Andersen [48] reports congenital color blindness (not tapetoretinal degeneration) occurring in 4 siblings, 2 of whom had in addition heredolabyrinthine deafness or a combined hereditary abnormality of the internal and middle ear. None had a history of middle ear disease. There was no consanguinity in the family. Three of the patients showed mental deficiency. Whether or not this was a chance combination is not yet known.

Luchsinger [49] reports 2 cases of auditory aphasia (sensory form). Patient 2 also had paramusia. From the standpoint of symptomatology there was false localization by the affected side in both patients; only loud tones could be heard with certainty on the affected side; the moment of false localization or of absolute loss appeared rapidly.

Professor della Cioppa [50] feels that with the modern advances in understanding of the nature and pathogenesis of deafness, the time has come for a more exact classification of cases of deaf-mutism. The

47. Hopkins, L. A.: Congenital Deafness and Other Defects Following German Measles in Mother, Am. J. Dis. Child. **72**:377 (Oct.) 1946.

48. Ry Andersen, S. R.: Congenital Total Colour Blindness Co-Existing with Heredo-Labyrinthine Deafness, Acta ophth. **24**:99, 1946.

49. Luchsinger, R.: Auditory Aphasia and Cortical Deafness, Schweiz. med. Wchnschr. **77**:347 (March) 1947.

50. della Cioppa, A.: Classification of Deaf-Mutism, Boll. d. mal. d. orecchio, d. gola, d. naso **60**:274 (July) 1942.

cases are divided into (*a*) those of a constitutional variety in the mendelian sense involving abnormalities in the paternal or the maternal chromosomes; (*b*) those of acquired deaf-mutism due to exogenous (usually infective) causes which damage the organ of hearing; (*c*) those of constitutional deaf-mutism of endogenous origin due to arrested or maldevelopment of the ear, including serious degenerative changes, such as otosclerosis, and (*d*) cases of acquired deaf-mutism due to intoxications or infections occurring before birth as well as to injuries during parturition.

The general classification into cases of congenital and cases of acquired deaf-mutism is confusing and not in accord with modern eugenic ideas. The usual concept of "congenital" refers to the condition of the subject at birth without taking into account whether the deafness is due to a constitutional defect or is due to an external cause which damaged or interfered with the development of the ear. On the other hand, deafness occurring after birth is called "acquired," although it may be a constitutional malady, such as otosclerosis or familial deafness.

In view of the foregoing facts, the author proposes dividing cases of deaf-mutism into those of prenatal and those of postnatal deaf-mutism, this division being based on known facts instead of speculation. The cases of each group can be divided secondarily into cases of constitutional and cases of acquired type when sufficient clinical facts are available. Finally, a third group—"deaf-mutism of unknown origin"—is reserved for those instances in which it is impossible to ascertain the precise cause.

Pang [51] cites the work of Crowe to show that the classic concept of impaired hearing of low tones with good hearing of high tones is no longer valid in the diagnosis of conduction deafness. Crowe, as well as the author, has found high tone impairment in children with obstruction of the eustachian tube due to lymphoid tissue. Experimental work and statistics are cited in detail. The author stresses nasopharyngoscopic study as well as the usual audiograms and examination of the ears. Treatment with the 50 mg. radium bomb or with radon is advocated.

Crowe [52] believes that if hypertrophic lymphoid tissue occurring around the eustachian orifices of children were irradiated, the deafness occurring later in life would be reduced 50 per cent. The method has been used for nearly twenty years. Many patients have been followed for fifteen years. The method is simple and safe.

51. Pang, L. Q.: The Diagnosis and Treatment of Early Conductive Deafness, Hawaii M. J. **6**:165 (Jan.-Feb.) 1947.

52. Crowe, S.: Irradiation of the Nasopharynx, Bull. Johns Hopkins Hosp. **80**:297 (May) 1947.

Fowler Jr. and Seligman [53] report on neurotoxic symptoms, vestibular and auditory, following therapeutic use of streptomycin. Two months after cessation of therapy 3 of 81 patients showed absence of vestibular response but normal audiograms. Two weeks after treatment 1 patient showed severe loss of hearing. One month after treatment he showed decided improvement in hearing; the vestibular response was normal throughout. Otic symptoms call for reconsideration of the therapy, but, if indicated, the administration of streptomycin should not be discontinued. Perhaps a different preparation of the drug should be tried.

Audiograms and vestibular tests should be made before the initiation of streptomycin therapy.

Hallberg and Horton [54] report 4 cases of sudden internal ear deafness in which the aural condition was treated by intravenous injection of histamine. They believe this type of deafness is a phase of the Ménière syndrome and that the pathologic changes involve the cochlear portion of the labyrinth alone.

Moe[55a] reports 1 case due to tuberculosis, 1 case due to multiple sclerosis or several foci of encephalomyelitis and 1 case due to tonsillitis followed by bilateral otitis media of mild degree and convulsions, then total deafness and a little later parotitis. In the third case the diagnosis was postinfectious encephalitis. There were several later episodes of convulsions, but eventually recovery of the patient took place, also recovery of hearing, as in the other 2 cases.

An excellent abstract of this article on transitory deafness has been published by Grove, to which the reader is referred.

Unlike Ciocco, Kristensen [56] finds no convincing relation between impairment of hearing and body type among weavers. He finds it is chiefly the asthenic weavers who show the earliest loss of hearing when exposed to noise. This difference is soon leveled out as all the exposed persons grow older.

HEARING AIDS

Approaches to the fitting of hearing aids are varied and range from one extreme of individualized fitting to the other of employing a properly constructed instrument for most of the usual cases. Carhart

53. Fowler, E. P. Jr., and Seligman, E.: Otic Complications of Streptomycin Therapy: Preliminary Report, J. A. M. A. **133**:87 (Jan. 11) 1947.

54. Hallberg, O. E., and Horton, B. T.: Sudden Nerve Deafness: Treatment by the Intravenous Administration of Histamine, Proc. Staff Meet., Mayo Clin. **22**:145 (April 16) 1947.

55. (*a*) Moe, R.: Transitory Deafness, Acta oto-laryng. **35**:20, 1947. (*b*) Grove, W. E.: Arch. Otolaryng. **46**:553 (Oct.) 1947.

56. Kristensen, H. K.: On Relation Between the Hearing of Weavers and the Body Type, Acta oto.-laryn. **34**:82, 1946.

and Thompson [57] present the principles of audiology which underlie the effective selection of hearing aids. Modern methods include the thorough study of the individual patient and his auditory impairment, laboratory tests of his performance with hearing aids and training in the use of the instrument selected. A thorough medical and audiologic study should rule out first the possibility of medical and of surgical treatment. It should determine whether the degree of loss and the type are such that the loss will be adequately compensated with an aid. Generally, those with losses for 512 to 2048 cycles per second averaging between 45 and 75 decibels for the better ear are most effectively helped. Also those with uniform loss of a conductive type get more help than those with irregular audiometric curves. The patient also must have the ability to comprehend language properly and to discriminate the phonetic elements of speech. To explore these things adequately, the investigator must include both the pure tone and the standardized speech tests. The writers feel that monitored live voice using the proper equipment is the most practical method of presenting speech tests in the typical clinical situation. When the audiologic examination shows that the patient should procure a hearing aid, the ear on which the instrument should be worn must be chosen. Some of the general rules are as follows: If there is a moderate loss in both ears with the patient able to use the telephone, the aid should be fitted to the ear not used in telephoning. If the difference of the two ears is 20 decibels or more for the 512 to 2048 frequency range, the ear with the lesser loss is chosen. A common exception to this, however, is the case in which the average loss of the poorer ear does not exceed 60 decibels. If the average loss of the two ears is approximately equal, the one with the more uniform loss or the more regular audiometric contour is to be preferred. Air conduction aids are usually used in preference to bone conduction aids except when medical contraindications to the use of an ear piece in the external auditory canal exist. The individual properly fitted ear piece is essential, and the impression made of acrylic or colloidal materials has been most satisfactory. In selecting the hearing aid, only instruments approved by the Council on Physical Medicine of the American Medical Association should ordinarily be considered. Also, those instruments having local representation for proper maintenance and service should be preferred. Finally, the instrument whose characteristics best conform to the needs of the patient as revealed by tests previously made should be chosen. The need for testing various instruments to evaluate the patient's, as well as the aid's performance, has been shown in the various rehabilitative

57. Carhart, R., and Thompson, E. A.: The Fitting of Hearing Aids, Tr. Am. Acad. Ophth. **51**:354 (March-April) 1947.

military programs. The important facets of efficiency which should be explored are sensitivity or gain, tolerance limit, hearing in noise and precision in oral discrimination. This information can be obtained by employing proper tests and special equipment. These procedures have been described in previous articles and reviews. To achieve maximum efficiency, the patient should receive proper auditory training and instruction in the proper use of his hearing aid. The writers stress the importance of establishing hearing clinics and programs which will make available modern procedures of aural rehabilitation to civilians. This requires cooperation between the otolaryngologist, who furnishes diagnostic skill, medical guidance and supervisory control, and the clinical audiologist, who supplies testing skill and the specialized instruction required.

Nichols [58] discusses the physical characteristics of hearing aids and shows the arrangement of the equipment used for testing these performance characteristics. The important things to determine are the amount of amplification, the shape of the frequency response characteristic, the maximum sound level which can be produced in the ear, and the degree and type of distortion of a transmitted sound. The amplification as measured in the laboratory is the difference between the sound level at the microphone of the aid and the sound level produced in the artificial ear by the ear phone expressed in decibels. A graph is made, known as the frequency response curve, to indicate this response. If the amplification is the same for all frequencies, the instrument is said to have a flat response characteristic, since the graph is a straight horizontal line. The tone control of the hearing aid is similar to that of a radio set. A change of tone control setting will change the response so as to give less emphasis to either the lower or the higher frequencies. The volume control merely increases or decreases the amount of amplification fairly uniformly at all frequencies. It also controls the maximum volume of the sound beyond which it cannot go. Distortion occurs when the wave form of a sound is altered in character by the hearing aid. This can occur when extraneous tones are received through the ear piece, as well as the applied sound. Noises arising in a hearing aid are of two types, electrical and microphonic. The common electrical noise is the hissing sound produced as the electrical current passes through the circuit elements of the aid. Microphonic noises occur when the aid is jarred or when it is rubbed against the wearer's clothing. Desirable characteristics of a hearing aid are mechanical ruggedness and freedom from noise, along with stability of performance, regardless of temperature and humidity. Although laboratory tests are useful for purposes

58. Nichols, R. H., Jr.: Physical Characteristics of Hearing Aids, Laryngoscope **57**:31 (Jan.) 1947.

of design, comparison and control of characteristics in the production of hearing aids, they should not be applied indiscriminately to problems of fitting or selection of hearing aids. Due consideration should be given to the differences which may exist between laboratory test conditions and the conditions under which the instruments operate when worn.

Saltzman and Ersner [59] recommend the use of a hearing aid to the patient suffering from tinnitus aurium associated with deafness who cannot be helped by other methods. Amplification of outside sounds masks the patient's head noises. This was brought out in the routine fitting of hearing aids. It was most efficacious in cases of otosclerosis in which the patient either was not suitable for or refused the fenestration operation. In cases of nerve deafness in which no extraordinary difficulties of tolerance are present, the hearing aid can give considerable relief from tinnitus. Even in cases of chronic adhesive otitis media it is helpful. According to Stevens and Davis, quoted by the writers, a loud tone masks tones higher than itself more easily than lower tones. The masking is greater when the tones lie close together in frequency. Most head noises lie within a frequency range of 100 to 200 or one of 5000 to 8000 at the outside fringe of the speech range. A hearing aid that will amplify frequencies 512 and 1024 to the extent of 40 decibels will cut out low pitch tinnitus most effectively, whereas one that amplifies 2048 and 4096 will drown out high pitch tinnitus readily. The ideal outside sound to drown out intrinsic tinnitus is human speech. The inner ear has been conditioned to damp and tolerate environmental noise but is disturbed by the least amount of noise that arises within it.

59. Saltzman, M., and Ersner, M. S.: A Hearing Aid for the Relief of Tinnitus Aurium, Laryngoscope **57**:358 (May) 1947.

Abstracts from Current Literature

Ear

ARACHNOIDITIS IN THE FOSSA CRANII POSTERIOR OF OTOLOGIC INTEREST. LARS PREBER, Acta otolaryng. **35**:271 (May-June) 1947.

The term arachnoiditis is used to designate chronic pathologic conditions localized to the cerebral or spinal arachnoid and consisting of circumscribed or diffuse thickenings and adhesions to the pia mater. In many cases inflammation and traumatic factors contribute to the occurrence of this condition.

Characteristic objective signs are almost always missing, and a clinical diagnosis of the condition, which may simulate a tumor, is difficult. As the result of adhesions, the subarachnoid spaces may become partially or totally shut off and cystic cavities filled with clear cerebrospinal fluid arise.

The occurrence of cystic spinal arachnoiditis giving rise to paraplegia was described by Schlesinger in 1898 and by Horsley in 1909. In 1909 Raymond and Claude published the report of a case of circumscribed serous meningitis localized to the cerebral cortex. This was the first case of cerebral arachnoiditis described in the literature. Foci of superficial encephalitis associated with arachnoiditis were observed and described by Bainey, Claude and others.

In the development of neurosurgery during the last decades, it has been observed that arachnoiditis, usually occurring at the base of the brain, near the optic chiasm and in the cerebellopontile angle, is caused by trauma or by otogenic or syphilitic infection. Davis and Havens, in 1931, studying these changes microscopically, distinguished three types of arachnoiditis, inflammatory, fibrous and hyperplastic. The cause of the arachnoiditis is often obscure, but Davis and Havens gave as etiologic factors focal infections, especially those originating in the petrous bone or in the accessory sinuses of the nose. In certain instances the arachnoiditis may result from an injury to the skull, with or without fracture, or from healed meningitis. Arachnoiditis with cyst formation is not an unusual complication of brain tumor.

Cerebral arachnoiditis is encountered in the cortex cerebri, the optic chiasm and optic tract and, oftenest, in the posterior fossa. The last-named location is of otologic interest, as arachnoiditis here may be caused by inflammatory processes in the middle ear or in the petrous bone or may follow operative procedures in these areas.

Subtentorial cystic arachnoiditis may produce the same symptoms as cerebellar disease, i.e., occipital headache, vertigo, nausea and vomiting, papilledema, nystagmus and kinetic and static ataxia. Horrax reported that in 33 of 676 patients with symptoms referable to the posterior fossa who were operated on by Cushing for suspected tumor of the brain no pathologic condition other than cystic arachnoiditis was encountered. It is often impossible to diagnose cystic arachnoiditis of the posterior fossa, but ventriculography is of great help.

In 1941 de Kleyn announced that he had found an unusual form of positional nystagmus, which he had observed in 6 patients with posterior arachnoiditis. The nystagmus arose if the patient in the dorsal recumbent position turned his head to the right or to the left. The same phenomenon was observed if the patient turned his head to the right or to the left while in the sitting position. According to Bárány, positional nystagmus in the turning movements of the neck might be due to restriction of the circulation in the blood vessels of the neck; but de Kleyn, in his cases of posterior arachnoiditis, could not produce the nystagmus by compression of the carotid artery or of the jugular vein. De Kleyn maintained that this form of positional nystagmus is caused by what are known as "neck reflexes" and that it appears only when there has been a change in the position of the head in relation to the trunk. It is supposed that the irritation which brings out the nystagmus arises from a disturbance in the circulation of the spinal fluid. At his clinic, Preber saw a case of positional nystagmus such as de Kleyn described in a case at his clinic, that of a woman who had had trauma to the skull.

In the differentiation of arachnoiditis and cerebellar tumor, Bing drew attention to the remissions and exacerbations of arachnoiditis, whereas cerebellar tumor is characterized by a gradual progression of symptoms. In particular, according to Brouwer, the absence of nystagmus in severe cerebellar syndromes should point to a diagnosis of arachnoiditis.

The site of predilection of cystic arachnoiditis of the posterior fossa is the cisterna pontis lateralis. The clinical picture of arachnoiditis of the cerebellopontile angle is dominated by symptoms referable to the eighth cranial nerve. Failure of function of this nerve may be due to fixed adhesions about it, as the result of adhesive arachnoiditis. Kroll stated that Gradenigo's syndrome is probably due to circumscribed serous meningitis at the apex of the pyramid. From the standpoint of differential diagnosis, it is difficult to make a distinction between a tumor of the acoustic nerve and arachnoiditis of the cisterna lateralis. According to List and Marburg, the cerebellar symptoms in arachnoiditis are very pronounced, while the loss of hearing is relatively slight and the labyrinthine function as a whole is little impaired.

In 1912 Bárány presented a symptom complex, based on anatomic data and on his own pathologic and experimental physiologic investigations, which, in his opinion, might result from cisternal arachnoiditis. The symptoms theoretically possible would be occipital headache, tenderness on pressure above the mastoid process, impairment of hearing, tinnitus, decreased excitability in the caloric test, past pointing outward in the pointing tests done from the wrist, facial palsy, ache in the occiput and behind the ear, diplopia and disturbance in taste in the posterior part of the tongue. There might also occur attacks of dizziness, nausea and vomiting and, more rarely, choked disk. Past pointing at the wrist on the affected side is pathognomonic of the Bárány syndrome only if cerebral control is eliminated. This phenomenon can be accomplished by having the patient, while executing the pointing test with one wrist, try to touch the tip of his nose with the first finger of his other hand.

In Bárány's clinical material on 30 patients, each had some or several of these symptoms. Bárány based his theoretic speculations for the most part on the anatomic investigations concerning the cisterna pontis lateralis made by Key and Retzius. The fifth, sixth, seventh and eighth cranial nerves run through this cistern. This cistern, which communicates medially with the cisterna media and laterally and posteriorly with the cisterna magna has its own choroidal plexus and

an independent supply of cerebrospinal fluid. The cistern also communicates with the remaining subarachnoid space, which stretches from the pons forward to the base of the brain.

If now, in conjunction with inflammation of the ear, syphilis or trauma, there arises a slight meningeal irritation with adhesions of the arachnoid and the pia, and possibly also the dura, then the cisterna lateralis may be shut off and become a closed space. Here, increased pressure may arise, owing to disturbed secretion and absorption of fluid. This raised pressure may be transmitted to the labyrinth and thus cause tinnitus and impairment of hearing. The acoustic, facial, trigeminal and abducens nerves, located inside the cistern, are exposed to increased pressure, as are, to some extent, the vagus and glossopharyngeal nerves. Hearing impairment and tinnitus may be due either to direct pressure on the nerve in the angle or to increased intralabyrinthine pressure. Pressure on the trigeminal nerve may produce retroauricular pain. Bárány did not observe any instance of facial paralysis in his cases. This may be due to the fact that the facial nerve is more resistant to pressure than the acoustic nerve, as borne out by the rarity of facial paralysis in the presence of acoustic tumor. Vertigo, as well as slight nystagmus, occurred in most of Bárány's cases.

Spontaneous recovery takes place in about two weeks; according to Bárány, the gradual increase of pressure within the cyst in the cerebellopontile angle gradually breaks down the adhesions and permits the cyst to empty itself into the surrounding or connecting subarachnoid spaces, resulting in recovery.

Lumbar puncture is thought to have a beneficial effect on the syndrome of Bárány, but it is hard to explain this on anatomic and physiologic grounds. If the disease is severe and takes a chronic course, surgical evacuation of the cyst is necessary; but even after such operation the tendency toward recurrence is great.

Of Bárány's 30 cases, the condition in 10 was due to freshly healed acute otitis. Kobrak described several cases under the designation "angioneurotic octavus crisis" which resembled Bárány's cases, and Marzuliez described 4 cases with similar symptoms under the name migraine otitique. In addition to these cases, there are only isolated reports of a similar condition in the literature.

Preber now presents the case of a woman aged 33 who for one-half year had had retroauricular pain on the left side. The pain and headache became intensified and was associated with the appearance of tinnitus of the left ear. Suddenly the patient noticed a decided loss of hearing in the left ear. Examination revealed an intact left drum membrane, tenderness over the left mastoid and occipital bone on percussion, left-sided perceptive deafness, diminution of the corneal reflex of the left eye, diminished excitability of the left labyrinth to caloric stimulation and constant lateral deviation of the left wrist in the pointing test, both in supination and in pronation. A roentgenogram of the internal auditory meatus revealed no abnormality. The reaction to the Wassermann test was negative; lumbar puncture showed a normal status. The day after admission to the hospital the patient suddenly felt a crackle in her head, with immediate relief of symptoms and pronounced improvement in hearing. Within five days the patient was completely free from the symptoms and all previous signs were gone. Her hearing was checked audiometrically, both during the course of the disease and after.

The possibility of tumor in this case was excluded by the sudden spontaneous recovery. Preber explains the sudden amelioration of symptoms and signs by the

fact that the increasing pressure in the cisterna pontis lateralis reached such a point that it broke down the adhesions which blocked off this space from the rest of the arachnoid.

There are a relatively large number of published cases of circumscribed arachnoiditis of the cerebellopontile angle in conjunction with otitis media and mastoiditis in which the diagnosis was not made clinically, but was made accidentally at operation. Davis described similar cases of disease which produced slowly progressive cerebellar symptoms of varying intensity, consisting of nystagmus, moderate dysmetria, incoordination of the upper extremities, ataxic gait, papilledema and signs referable to the cranial nerves in the cerebellopontile angle. The diagnosis usually made was cerebellar abscess. At operation no abscess was found; instead, a thickened, opaque, grayish arachnoidal membrane, with cystic fluid beneath it, was encountered. After evacuation of the cyst the symptoms disappeared.

Chronic otitis provokes arachnoiditis more frequently than does acute otitis and usually gives rise to symptoms suggesting cerebellar trouble, according to Sture, Berggren, Mygind, Bing, Jenkins and others. Owing to the intimate association between pathologic changes in the ear and the meninges, it is probable that milder degrees of arachnoiditis occur not infrequently as otogenic complications, although they may heal spontaneously without giving rise to symptoms. Preber found such a condition in a case at his clinic in which at operation 10 to 15 cc. of fluid was drained from the cisterna pontis lateralis, although normally this cistern contains only 3 to 4 cc. of fluid. Within five months the tinnitus, which was relieved by the operation, recurred in the same ear, thereby suggesting relapse of the cystic condition in the cistern.

GROVE, Milwaukee.

Larynx

PRESENT CONCEPTS OF LARYNGEAL DISEASE. FRANCIS L. Lederer, J. Speech & Hearing Disorders **13**:11 (March) 1948.

Ultimate progress in laryngology depends on the training given the laryngologist and the speech pathologist and on the education of the layman. There is need to inventory the patient as a total person. This embodies a careful history, a thorough examination and a complete analysis of the social, psychologic and economic status of the patient. Vocal abuse and the present day prevalence of smoking may some day be replaced by other factors which grow out of man's so-called civilized environment. Only by the continuous education of all groups interested in laryngeal function will progress be pushed forward. A brief review of the history of laryngology is presented.

PALMER, Wichita, Kan.

CANCER OF THE LARYNX AND ITS TREATMENT BY RADIUM. ALEXANDER A. CHARTERIS, J. Laryng. & Otol. **62**:163 (March) 1948.

The aim of radium treatment is to make use of the selective action of the gamma rays to deliver such radiation as will cause regression and disappearance of the malignant tissue while producing minimal damage to the adjacent normal tissue. The rules which govern the tolerance of the tissues to various dose levels are briefly discussed. Various degrees of reaction are inevitable after radiotherapy, and it is thought that lesions occupying the middle of the vocal cord which are suitable for fenestrations usually manifest negligible reaction after application of radium needles.

From 1930 to 1940, 17 patients were treated in this manner. To date, 6 have survived. Radium beam therapy, utilizing 5 Gm., has been used since 1942 in the cases of more extensive carcinoma of the larynx. Of 30 patients thus treated, 9 have survived.

LeJeune and Steele, New Orleans.

Nose

Tissue Changes in Sinus Membranes After Penicillin Treatment. Ralph A. Fenton and Olof Larsell, Ann. Otol., Rhin. & Laryng. **56**:245 (June) 1947.

Previous work of the authors showed that "almost every sort of surface application to such [sinus] membranes becomes an irritant unless its strength be isotonic." Howes found that various chemotherapeutic agents—benzalkonium chloride U. S. P. (zephiran chloride®), chlorophenol and tyrothricin—prepared in solutions strong enough to inhibit bacterial growth—were toxic to epithelial cells and fibroblasts. Streptomycin and 4-amino-2-methylbenzine sulfonamide hydrochloride (sulfamylon®) were mildly inhibitory to cell growth. Penicillin calcium, however, proved inert as to cellular damage. The authors' own observations convinced them that penicillin used locally in the sinuses is of value only in acute and subacute stages of infection. No reports of microscopic examinations of acutely inflamed sinus membranes had come to their attention; so they produced infection of the frontal sinuses of a number of cats with a culture of a virulent hemolytic streptococcus isolated from the human upper respiratory tract and examined the results after the use of penicillin.

The observations indicated that the acute inflammatory reaction appears to continue longer after the sinuses have been locally treated with penicillin than in the earlier experiments in which no such treatment was employed. This suggests that the active stage of polymorphonuclear phagocytosis is of longer duration and is therefore, in all probability, more effective. Some allege that penicillin solution is a local cellular irritant, exciting polymorphonuclear activity, but it may possibly exercise a true bacteriostatic stimulus on phagocytosis, at least in living ciliated membranes. The experiments seemed to indicate that in the cat streptococci are rapidly destroyed on the surface and in the epithelium of acutely inflamed sinus membranes through the bacteriostatic properties of penicillin sodium administered in the strength of 2,000 units per cubic centimeter of isotonic sodium chloride solution. For perfusion of acutely inflamed sinuses of human beings and for intratracheal injection, the authors found that a solution of 100 units per cubic centimeter causes no burning or irritation. This adds strength to the hypothesis that phagocytosis is greatly accelerated by the local use of penicillin.

M. V. Miller, Philadelphia.

Miscellaneous

Relation of Lesions of the Tongue in Children to Niacin Deficiency. Herry Bakwin, Margaret S. Tenbrinck, Maxine L. Stern, M. G. Engel, H. S. Reardon and James S. Winn, Am. J. Dis. Child. **74**:657 (Dec.) 1947.

This study was made to determine whether certain conditions of the tongue in children could be influenced by treatment with nicotinic acid U. S. P. From 1942 to 1945, 225 children with changes in the tongue were seen in Bellevue Hospital,

New York; of these, 60 were observed, and these observations form the basis of this report. Four types of lesions were found: (1) acute glossitis, (2) glossitis migrans, (geographic tongue), (3) mild chronic swelling of the tongue and (4) fissures of the tongue. Large doses of nicotinamide U. S. P. (8 to 20 mg. per kilogram of body weight) were given to one group, and nothing was given to the control group, with the result that the acute glossitides improved spontaneously or after chemotherapy. The group with swollen and fissured tongues improved with the drug more than a similar, untreated, group. In no patient was complete cure effected, though treatment of 2 patients was continued longer than twenty-four and twenty-six months, respectively. The nicotinamide therapy had no effect at all on glossitis migrans. The diets of children with changes of the tongue were not demonstrably different from the diets of children without such changes. The authors conclude that nicotinic acid has a favorable effect on the nutrition of the tongue, but maintain that the results do not substantiate the view that lesions of the tongue commonly seen in children are always due to nicotinic acid deficiency.

VOORHEES, New York.

WHY STAMMERERS SUFFER. SATYA NARAYAN PUROHIT, J. Speech Disorders **12**:419 (Dec.) 1947.

The author, herself a stutterer, discusses the problems of stuttering. India has practically no source of corrective care for this disability. Stutterers suffer from the attitude of normal speakers; they have a terrific drain of energy because of the associated intense fear of being snubbed, sneered at or misunderstood, prompted by past experience. In conclusion, "a stammerer—until a specialist comes to his rescue and cures him—must neither be snubbed nor thought abnormal, nor be sneered at and 'made a laughing-stock,' a target of typical, indecent joking and mocking which will turn his life into a virtual hell through no fault of his own. He must be treated very sympathetically and be given a chance to lead a happy life on this crust of earth."

PALMER, Wichita, Kan.

NUTRITION IN OPHTHALMOLOGY AND OTOLARYNCOLOGY. ISAAC H. JONES, HAROLD S. MUCKLESTON, EUGENE R. LEWIS and GILBERT ROY OWEN, Laryngoscope **57**:733 (Dec.) 1947.

Jones and associates reiterate some of the ideas they presented in previous papers, including the statements (1) that no vitamin will help a condition that is not caused by the lack of it, and (2) that therapy has an embryologic approach, namely, that each germ layer demands an oil-soluble and a water-soluble vitamin. The ophthalmologist and otolaryngologist are in a good position to observe changes caused by dietary deficiency.

Animals and primitive peoples, with their instinct and intuition, are apt to choose better food than does civilized man.

The mechanisms of the roles of various nutrients are beginning to be known, but much more is yet to be learned. Many new substances are being recognized as important to health. The plea is again made for the use of natural foods, the refined foods, white flour for instance, being often deficient in nutrient value. The roles of the proteins and minerals are discussed. Study of both these groups has been neglected in the past. Each vitamin is discussed separately and in some detail.

Hitschler, Philadelphia.

OPERATION IN TREATING SECONDARY HARELIP DEFORMITIES AND DEFECTS OF THE UPPER LIP RESULTING FROM CANCER. V. H. KAZANJIAN, Plast. & Reconstruct. Surg. **2**:307 (July) 1947.

In cases of cleft palate there are many striking departures from the normal, the most important of which are the underdevelopment and distortion of the maxillary bones. The lack of normal development of the maxilla affects the contour of the upper lip and the lower part of the nose. Kazanjian finds this condition more pronounced and commoner in those who had been operated on during childhood than in those who had not previously been operated on. The question is raised whether the early operation may not have caused damage to the blood supply of the maxillary bones or whether the cicatricial tissue following operation causes a delay in the proper expansion and growth of the palate.

In the opinion of the reviewer, very early operation is advisable only in cases of the most extreme deformity. It should also be borne in mind that all instances of cleft lip and cleft palate represent embryonic developmental defects. The Estlander-Abbe operation is outlined in considerable detail. Case histories are given, and excellent photographs are included in the article.

SELTZER, Philadelphia.

WHY THE INDIAN DOES NOT STUTTER. JOHN C. SNIDECOR, Quart. J. Speech **33**:493 (Dec.) 1947.

Eight hundred Indians were interviewed, and data were obtained indirectly on 1,000 more. None of the 800 was a stutterer; 2 half-breed Indians who stuttered were discovered among the 1,000, with a possible third. The author believes this incidence is significantly beyond the probability of chance and discusses the low frequency on the basis of the following factors: 1. Difficulties in handedness cannot be involved. 2. Children injured at birth may not survive well Indian culture. 3. If emotional instability is the cause of stuttering, it would seem that the Indians apparently have fewer reasons for stuttering than the white man. 4. Indians do not have a direct word for stuttering, at least in the Bannock and Shoshone tribes, and this semantic difficulty is therefore not present. 5. The factor of neuroses does not appear to be involved in any way.

PALMER, Wichita, Kan.

MASSIVE LOCAL INFILTRATION OF PENICILLIN IN SURGICAL CONDITIONS. SANTE CIANCARELLI, Rome, Ditta Luigi Pozzi, 1948.

The author lists a considerable number of lesions, including tonsillitis, for which he claims operative procedures may be eliminated by the use of penicillin in massive local doses. He describes the local treatment of pharyngitis and tonsillitis by the injection of 200,000 to 400,000 units of penicillin into the peritonsillar space and the tonsil itself. He believes this treatment is effective for such conditions as Ludwig's angina, suppurative parotitis (parotitis phlegmonosa), chronic abscesses and fistulas. The author concludes that infection of any organ or tissue accessible to a needle and syringe should be treated by local infiltration of 200,000 to 400,000 units of penicillin two or three times daily and that smaller doses should never be given because of the danger of making the bacteria penicillin resistant. The length of treatment depends on the extent and duration of infection and on the objective, subjective and bacteriologic changes. The injections of penicillin must be continued

without diminution in dosage until the infection has entirely disappeared. Ciancarelli contends that this therapy eliminates the necessity of administering this biologic substance by any other method, as the infiltration will secure the necessary local effect and, in those cases where needed, will produce a therapeutic level in the blood. He also states that this treatment is useful in cases of mixed infections with gram-negative bacteria, when a sulfa drug or streptomycin is added to the penicillin.

MORICONI, Trenton, N. J.

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